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The fact that an article appears in this magazine does not indicate approval of the views expressed in it by any one other than the author. It is our policy to print articles on subjects of interest in order to stimulate thought and promote discussion; this regardless of the fact that some or all of the opinions advanced may be at variance with those held by the Armed Forces Chemical Association, National Officers, and the Editors. It is the responsibility of contributors, including advertisers, to obtain security clearance, as appropriate, of matter submitted for publication. Such clearance does not necessarily indicate indorsement of the material for factual accuracy or opinion by the clearing agency.

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FRONT COVER
By CHARLES MENDEZ

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ARMY PROPELLANT RESEARCH

By **DR. RALPH SWANN**
Technical Director
Ordnance Missile Laboratories Division
Army Rocket and Guided Missile Agency

This story written at Redstone Arsenal brings to the chemical industry and its engineers and scientists some of the problems that confront Major General Schomburg and his staff in their search for rocket and missile propellants.

THE EDITOR

Maj. Gen. August Schomburg, Commanding General, Army Ordnance Missile Command, Redstone Arsenal, Ala.

FOR ARMY USES, the requirements which we place on propellants are severe. They must stand rough handling, must be safe, must withstand high and low temperatures and cycling between these temperatures, and they must be ready to fire on a moment's notice and you must also be able to store them subject to a decision to fire later.

In the Army's first missiles we used liquid propellants. Liquids have the advantage of being controlled by valves so that thrust is easily controlled. However, liquid propellants were unstable, just as nitric acid and liquid oxygen are unstable. So to make our missiles more nearly like conventional artillery ammunition, we went to solid propellants.

The Army's early successes in this field were with double-base propellants, that is, propellants composed of cellulose and nitroglycerine. These early double-base propellants were brittle, and we had to protect motors with electric blankets in cold weather.

Case-Bondable

Later efforts produced a composite propellant which was made up of a mixture of a liquid polymer, polysulfide, which is a type of rubber and a solid oxidizer. This propellant was cast in the motor case and upon curing to a solid mass bonded itself to the motor wall. Called case-bondable, this propellant is rubbery and therefore less affected by temperature changes. This was a real advancement.

Since this type of propellant now enjoys widespread use we might ask, "What are the desired properties of solid propellants?" Answers come under a number of headings.

1. The rate at which the propellant burns under the operating conditions, that is, pressure and mass flow rate, is of major importance:

a. It is desirable that the range of burning rates available be as broad as possible. Some systems require high burning rates, others low burning rates, and some in between. The greater the latitude the rocket designer has in this the better his designs are. Automobile engines could not be nearly as efficient and of such high performance as they are if the design were limited by use of the low octane gasolines.

b. It is desirable that propellant burning rates be insensitive to changes in the ambient temperature. This permits comparable performance at all climatic conditions.

c. Low sensitivity of burning rate to pressure variations is also helpful.

2. From a physical properties standpoint, propellants should be strong and elastic at all service temperatures and should be able to stand temperature cycling and rough handling. The Army has much more stringent requirements in this respect than have the other services.

3. Chemical and mechanical stability should be excellent at high and low temperatures to permit long storage.

4. Propellants must be easily ignitible at all temperatures.

5. They should preferably be nondetonating under any conditions.

6. The density should be as high as possible to minimize motor size and consequently, motor weight.

7. Raw materials and facilities must be available for manufacture.

8. Consistency of the mixed propellant should allow casting directly into a motor case containing a mandrel.

9. Conversion to a rubbery solid should be a simple process carried out as near room temperature as possible and resulting in a strong bond between propellant and motor wall.

Case-Bonding

The Army pioneered the case-bonding method of loading rocket motors and first proved its practicability. This leads to motor designs significantly more efficient than those using the non-bonded, cartridge-type grain.

Let us now consider in detail the double-base system and, later, the composite.

For improved performance, the burning rate should be independent of the combustion pressure. This has been achieved in double-base propellants by employing the plateau and mesa effects obtained by use of metallo-organic additives. Thus, with the elimination of pressure variations, thinner walled chambers can be used in rocket design with significant weight savings and, hence, improved performance. Both the Army and Navy have placed substantial research effort in bringing this phenomenon to fruition, and there now exist a number of double-base compositions which employ this characteristic to advantage.

Impulse Increase

Currently, we are looking for ways to increase the propellant volumetric impulse by use of high-density additives. These additives must be combustibles yielding primarily gaseous products.

To raise the specific impulse, use is being made of light metals such as aluminum and boron. These metals have high exothermic energy of combustion which increases gas temperature and, consequently, gives increased specific impulse. There is a point of diminishing return, however, because the products contain solids. Also, new liquid explosive prasticizers are being studied to eliminate such difficulties as high volatility, high impact and thermal sensitivity, and high freezing point which are associated with use of nitroglycerin.

One of the most difficult problems facing us with double-base propellant is its poor physical properties is that of ignition at low temperatures where shock from the igniter can cause the grain to crack. The resultant increased burning surface causes increased pressures which may result in motor blow-up. One method of improving this situation is through the design of more gentle igniters.

Disadvantages

The one really serious disadvantage of conventional double-base propellants is that they cannot be case bonded and used successfully over the required wide temperature range because of these poor physical properties. This led to development of a family of propellants not classifiable as either double-base or composite. It has characteristics of both in that it uses plasticized nitrocellulose primarily as a binder and ammonium perchlorate as an oxidizer. This family of propellants is case bondable. It shows excellent promise for future applications.

In spite of great interest in the composite propellants for various missile applications, the double-base type is not being abandoned. In fact, there are a number of applications where only the double-base is suitable. The double-base propellants are expected to remain competitive with composites for a long time because they are nearly smokeless, are relatively low in cost, and have good stability characteristics. Not to be overlooked is our existing large industrial capacity for their manufacture. The new family of composite-nitrocellulose will permit utilization of the same facilities.

Turning to the composite propellants, these grains consist of polymers filled with approximately 75 percent of inorganic oxidizers, chemical stabilizers, and combustion catalysts. The types used by the Army are cast directly into the motor and bonded to its wall. This provides support for the grain, thermal protection for the motor case, and gives an increased mass ratio. However, some compositions must be cast into separate molds and loaded separately into the motor as conventional double-base grains are.

Matched Coefficients

We would like to case bond all propellants, but this can be accomplished only if the coefficient of expansion of the propellant can be approximately matched to that of the motor case. Unfortunately, the expansion coefficients are 10 times greater than those of common steels. Polymer chemists build in rubbery characteristics to enable this difficulty to be partially circumvented.

Composite propellants represent significant improvement in over all specific impulse and

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ARMY PROPELLANT RESEARCH

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have been able to retain its rubber-like qualities down to $-65°F$ and thereby meet to a degree both the hot and cold military temperature requirements, as well as increase its resistance to igniter shock. We are not yet able to do this with the desired high reliability.

A notable example of a good propellant polymer is the polysulfide synthetic rubber. We are now working with nine different compositions based on this polymer. The polybutadiene polymers are another and newer example. Other polymers, which we expect to further improve performance at low temperatures, are being developed.

Future Propellants

Now what are the future prospects in solid-propellant technology?

One thing that is very necessary for extremely high performance is a dense material with a specific impulse of the order of 300, but it has been found that about 250 is the maximum realizable value for any system based on carbon, hydrogen, oxygen and nitrogen.

You may ask, "What better possible systems are there?" First, let us define the specific impulse in thermodynamic terms. We can state that specific impulse is proportional to the square root of the flame temperature divided by the average molecular weight of the exhaust gases. Therefore, we wish to maximize flame temperature and minimize the average molecular weight of the gaseous products of combustion. For conventional propellants, these values are fixed within a narrow range by certain chemical equilibria, that is, dissociation of water and carbon dioxide.

In one approach to obtaining higher energy, theoretical calculations have been made on combustion of fluorine compounds with light metals. It has been shown that specific impulse of about 280 may be achieved. The success of this program depends on the synthesis of the proper fluorine compounds as oxidizers. These compounds will contain loosely bound fluorine.

Burning Rate Important

Previously, it was indicated that the burning rate of a propellant is important. We could use in certain instances very high rates—20 to 30 inches per second at pressures below 500 psi. This would permit us to use what we call "cigarette-burning" charges, which burn from the end and allow nearly 100 percent volumetric loading, as well as other design advantages.

The absolute burning rate of presently available propellants, though improved, is still temperature-sensitive to the extent that it complicates rocket and missile design. This ambient temperature sensitivity causes variations of thrust, burning time, chamber pressure, and total impulse, all of which affect weapon accuracy. To overcome this, complex and costly missile fire-control and guidance systems are required. Furthermore, these variations demand overdesign of metal parts, penalizing us in weight.

Industry Can Help

Finally—and this is an area where industry can very likely help us—we must understand better the structures and properties of polymers so we can tailor them for specific applications. We want to develop new polymers having low modulus of elasticity, great elongation as $-70°F$, and good tensile strength at $+165°F$.

The military requirements that will shape the Army's future development program are:

1. Storage and performance in adverse environment.
2. Improvement of motor performance by means of higher over all specific impulse.
3. Improved control of thrust and burning time.
4. Reduction of smoke, flash, and debris.

In summary, here are some of the things industry might provide.

1. New high-energy polymers.
2. Chemical reaction systems which get away from the water-gas reaction.
3. New oxidizers superior to perchlorate in oxidizing potential per unit weight.
4. Ways to further improve physical properties of double-base propellant and add more energy to nitrocellulose.
5. Both positive and negative burning-rate catalysts.
6. Devise means for thrust regulation and thrust termination without imposing undue weight penalty on the motor.
7. Assistance in improving our production processes to enable manufacture of large numbers of motors to quite rigid specifications.

In the end, we hope to be able to tailor-make a propellant to fit any requirement of the designer so that he can have utmost freedom to meet the military requirements placed on weapons and then be able to reproduce these results in quantity with high reliability.

Army contractors and installations are presently attacking these problems with zeal and dedication, but we also need the ideas and the talents of all interested industry to provide full solutions.

DEFENSE MOVES ON SINGLE MANAGER FOR ELECTRONIC SUPPLY

Chemicals may be slated for future study

By DALLAS HALVERSTADT

FOR THOSE who prefer numerical figures, there are some 950,000 items of electronic supply and equipment within the Department of Defense. These are supply items principally of radio, radar, telephone and teletype systems, and component parts.

For those who think in dollars, these items involve an inventory of $2½ billion, with annual purchases running another billion and one-half dollars. The purchases hold the inventory level.

For those who are concerned with spending, and the Comptroller General of the United States is one, there is the belief that a single effort, or, putting it another way, a consolidation of all efforts in management of electronic supply will result in savings.

Four Systems

At present there are four independent supply systems. One each for the Army, Navy, Air Force and Marines.

The Comptroller, whose staff made a study of these four electronic supply systems, recommended to the Secretary of Defense that considerations be given to a single manager of electronic supplies at the wholesale level. His recommendations went farther and stated that the central supply organization should:

1. monitor new equipment into the system
2. review, coordinate and consolidate requirements
3. be responsible for all procurement
4. determine supporting spare parts for new items
5. own all wholesale stocks
6. control and manage maintenance programs
7. store and distribute supplies
8. dispose of excess material

Problem Area

The Comptroller's report on this subject, which went to the Congress, outlined poor coordination among the services with electronic items of supply, stating that this allowed additional costs. The report said that equipment was at times in abundance with one service and in short supply with another. Purchase prices for identical items have varied from supply system to supply system. Repair facilities failed on occasion to render the best service to the Defense Department as a whole. Administratively there are six independent organizations performing either the same or similar stock-management functions. A great part of this work is done electronically and consolidation would, the Comptroller's staff reported, allow for savings in administrative costs which now exceed $25 million annually.

The Comptroller believes that the dollar advantage in his recommendations could run into the millions. It must be remembered that the savings are to be gained from a more efficient management, and without any attempt to alter military requirements of the four services.

Military Problems

Most of the time military and naval leaders agree that cost accounting procedures for housekeeping functions are efficient. However, they do point out that they are preparing to fight an enemy as yet undetermined, at time unannounced, at a place not exactly located, and that the struggle, if it starts will continue for an unknown length of time.

One thing is clear and that is if, and when, war starts, the military never has too much of anything. This can and does lead to supply problems like those mentioned in electronics.

The Armed Forces Supply Support Center is now engaged in a study and analysis of electric/electronic supplies. If you were pronouncing it the way it is written, it is called electric-slash-electronic supplies. This includes category items in Federal Supply Group 58 and Federal Supply Group 59.

Analysis Chief

Colonel J. R. De Lucca, Chief of the Analysis Staff, Armed Forces Supply Center, said that the recommendations will go to the printer on 31 January, and the formal presentation to establish a single manager assignment will be presented to the Armed Forces Supply Support Council on 14 February.

Establishment of a single manager at the wholesale level would centralize many of the supply functions. It would be the largest single manager in the Defense Department with some three and one-half million items in the Federal Supply Groups and 950,000 of those items are listed as electrical/electronic.

A single manager would curtail some of the activities of the four services, but would change nothing for the troops in the field. For example, a missileman at a Niki base needs an electronic part for his tracking or weapons system. He would draw the part in the same manner as always, except his source of supply would be comparable to the retail level in the civilian economy.

Each of the four services would handle and distribute their supplies with the help of the single manager acting as their wholesale source of supply. Special electronic items which are not stocked by the single man-

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what's your best estimate?

. . . a quiz for Chemical Executives who want to keep posted

QUESTION 1. In the petrochemical industry, price trends have not been uniform in recent years. Many major products have remained stable in price, some have gone up, quite a few have gone down. Do you know what the trend was for the following products from 1957 (third quarter) to 1959 (third quarter)?

	UP	DOWN	STABLE
AMMONIA	☐	☐	☐
BUTADIENE	☐	☐	☐
CARBON TETRACHLORIDE	☐	☐	☐
ETHYLENE OXIDE	☐	☐	☐
ISOPROPANOL	☐	☐	☐
STYRENE	☐	☐	☐

QUESTION 2. Since World War II, The Lummus Company has designed, engineered and/or constructed plants to produce many of the major petrochemicals. For which of the products listed above has Lummus done work?

AMMONIA ☐ BUTADIENE ☐ CARBON TETRACHLORIDE ☐
ETHYLENE OXIDE ☐ ISOPROPANOL ☐ STYRENE ☐

ANSWERS 1. *Ammonia and Ethylene Oxide remained relatively stable in price over the interval mentioned. Carbon Tetrachloride and Isopropanol prices went up; Butadiene and Styrene prices dropped. (Data from Petroleum Refiner—January, 1960).*

2. *All of them . . . as well as dozens of other chemicals and petrochemicals. Since 1945, Lummus has designed, engineered and constructed over 800 chemical and petrochemical installations throughout the world. Consider Lummus when planning your next project.*

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DEFENSE MOVES

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ager would be handled by each service as needs require.

Largest Yet

The Armed Forces Supply Support Center feels that this is the largest study it has so far undertaken, and the results of its recommendations may provide guidance and patterns for other type supplies in the Defense Department.

A single manager study for chemicals was under consideration at the time the electrical/electronic study was undertaken by the Armed Forces Supply Support Center. There was a lack of agreement among the services to study chemicals at that particular time, and so chemicals were postponed for future study while the single manager recommendations were begun for the electrical items.

The study and recommendations for a single manager for chemical supplies is now earmarked for future study.

Preliminary Talks

In the preliminary talks early this year, there were six classes of chemical supplies marked for future study for a possible single manager assignment. These classes by Federal Supply Group and description follow:

Class 6810—Chemicals
6820—Dyes
6830—Gases: Compressed and Liquified
6840—Pest Control Agents and Disinfectants
6850—Miscellaneous Chemical Specialties
8120—Gas Cylinders

As to these six classes, the services made the following comments:

Army

The Army considered these chemicals to be but a part of the chemical commodity range, and requested that the single manager determination should be made on the entire basis of chemical supply. Examples of material mentioned by the Army were:

Class 1040—Chemical Weapons and Equipment
1365—Military Chemical Agents
1380—Military Biological Agents
3650—Chemical and Pharamecutical Products Manufacturing Machinery
3655—Gas Generating Equipment
4230—Decontaminating and Impregnating Equipment
4240—Safety and Rescue Equipment
6630—Chemical Analysis Instruments
6640—Laboratory Equipment and Supplies
6665—Hazard Detecting Instruments and Apparatus

Navy and Marines

The Navy recommended that the six classes of chemicals in the original grouping be assigned to the Single Manager for Industrial Supplies. The Navy as well as the Army considered the six classes failed to encompass the entire area of chemical material. The Navy asked for more supply assignments and offered to provide a single manager of "Industrial and Medicinal Chemicals and Gases," contained in the following:

Group 65—Medical, Dental, Veterinary Equipment and Supplies
Group 68—Chemical and Chemical Products
Group 80—Brushes, Paints, Sealers and Adhesives
Class 8120—Gas Cylinders

The Navy also requested assignments in Class 3650 and 3655 previously identified by the Army.

Beginning this October, the Navy was given the assignment for Brushes, Paints, Sealers and Adhesives. Navy also has assignments for petroleum (Military Petroleum Supply Agency) and pharmaceuticals (Military Medical Supply Agency).

Air Force

The Air Force recommended that this material area be deferred for future study because of the wide range of chemical products, such as dyes, solvents, acetone, repellants, etc., many with peculiar or special applications. The Air Force recommended that two classes of supplies be excluded from this study. These were:

Class 2620—Tires and Tubes, Pneumatic, Aircraft
6620—Engine Instruments

The chemical study was tabled and the present one on the subject of electric/electronic supplies was undertaken. Recommendations and findings of the Armed Forces Supply Support Center on this subject will be the next move in the Defense Department.

HAPPY HASSENPFEFFER

It may have started when rabbits found it easier for them to multiply than to add or subtract. At any rate, the demand for rabbits feet certainly multiplied when they were free as luck charms to celebrate the lucky occasion of a new Heyden Newport Chemical Corporation plant in New Jersey.

The Company was surprised at the tremendous demand for luck charms in the scientific community. The rabbits feet may have created more stir among outsiders than the business reasons for a new plant. And everybody seems to be happy.

AMERICANS AND ITALIANS BUILD CHEMICAL PLANT

The United States Rubber Company and Rumianca, S. p. A. will produce polyvinyl chloride resins at Pieve Vergonte, Italy. The American company will furnish technical and engineering services for design and initial operation of the new plant. The Italian company, with main offices in Torino, will train personnel in the U.S. and build and operate it. Plant capacity is to be 10,000 metric tons, and Rumianca is licensed to manufacture and sell vinyl resins.

PURDUE HOLDS APRIL SYMPOSIUM

Purdue University will hold the third "Symposium on Information and Decision Processes" on the campus next April.

Complete details may be obtained from Dr. Robert E. Machol, School of Engineering.

RECENT DEVELOPMENTS IN AIR FORCE R&D

Rocket Technology: This effort is a continuing one with analytical studies supported first by small scale testing, then full scale development, and finally testing of pre-prototype items. The development of solid propellant segmented motors offers great future use for large boosters. A technique known as segmented grain motors is being studied to demonstrate a 20 million-pound per/sec impulse. Exploratory efforts are under way to join motor segments of different case materials. Nozzle throat designs are under study to better withstand heat of solid propellant exhausts, and to improve the thrust of solid motors. Scope of this effort should be increased, the Air Force believes, to fully exploit solid propellant motors for tomorrow's military space missions.

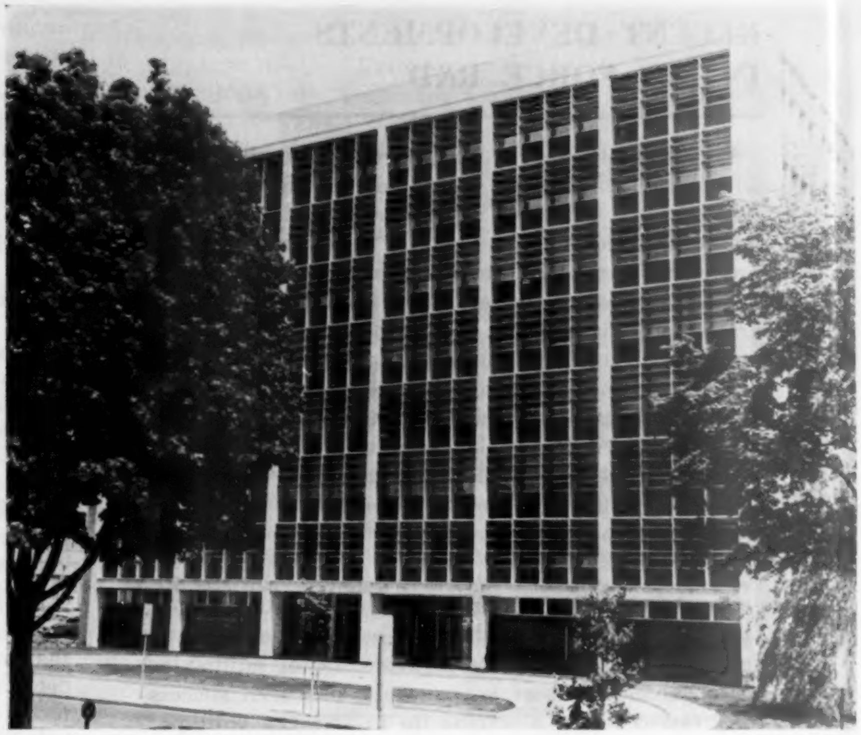
Crew Stations in Space Vehicles: Contracts with industry and in-house studies are being directed toward design of enclosed crew compartments for multi-place space vehicles. A seat for crewmen has been successfully tested under a strains up to 16.5 G's with personnel taking part in the tests. Studies in crew escape systems for use at speeds up to 35,000 ft./per sec. and altitudes of 100 miles have produced preliminary specifications. Requirements are for a capsule that can eject in space, re-enter atmosphere and make safe landing on the earth's surface. Thinking ahead of this, rescue may require escape from a disabled vehicle and the rescue in space by another vehicle.

Ramjet: Present technology includes analytical and experimental efforts on inlets, combustion systems and exhaust nozzles for acceleration and operation at Mach 15.

Needed Research: An understanding of the physical and chemical kinetics associated with re-entry of vehicles travelling with orbital velocity is not at hand. This makes it impossible to define accurately the re-entry corridor for lifting the vehicle re-entering the earth's atmosphere from its parabolic type trajectory. Another problem involves the dynamics of two or more vehicles moving in space on an equal time basis. Structure techniques for high temperature environment is still to be achieved for future vehicles. Independent thinking in these many physical sciences and technological fields is invited by the Air Force. Every idea sent to the Air Force R&D Command will be carefully evaluated.

Flight Dynamics: This effort is directed toward gas dynamic problems of re-entry flight of any vehicle, so that vehicle shapes may be developed with maximum performance. Also, to develop launching and alighting techniques for wheels, tires, brakes of aerodynamic vehicles, and recovery of missiles and other re-entry vehicles.

Electrical Components: Electronic materials research is being done with Ferrite, Garnets, Ceramics, Dielectrics, Nickel Alloys, Indium Compounds, etc., in support of electronic parts requirements.



The new 8-story home of American Chemical Society, 1155 16th Street NW., a few blocks from the White House, Washington, D. C. The building was dedicated to the Scientific and Professional Advancement of Chemistry and Chemical Engineering.

AMERICAN CHEMICAL SOCIETY DEDICATES NEW HEADQUARTERS

THE AMERICAN CHEMICAL SOCIETY which began with a Post Office Box in Brooklyn now has another address. It is a new eight-story building in the Nation's Capital dedicated to the advancement of chemistry and chemical engineering.

The span of time between these two events is 86 years.

A high school chemistry teacher who was the first General Secretary of the organization is now supplanted by 600 employes on full or part-time. The membership of the Society is 91,000.

Chemistry in the days of the Brooklyn Post Office Box was a matter of salt, soap, gunpowder and some acids. Since that time the chemical industry and use of chemicals is an accurate yardstick to measure the economic and industrial development of a nation.

More than that, chemistry is the backbone of a national defense. On this score, too, the American Chemical Society has kept well abreast of the changing times. Its programs to help research and to disseminate information have done much to bring the modern chemist into his own.

Charles A. Thomas, Chairman of the Board, Monsanto Chemical Company, who spoke at the Scientific Symposium of the dedications of the new headquarters, stated that the volume of chemical business has multiplied by 60 times since the turn of the century.

'The success of the chemist in meeting the needs of the public has had a great deal to do with his professional stature in the eyes of that same public," Mr. Thomas said. "But the American Chemical Society deserves a large share of the credit for raising the title of chemist to its present significance, and for doing this within the span of a single generation."

"From my point of view," Robert G. Ruark, Vice President, Technical Corn Products Company, told the luncheon group at the ceremonies, "the greatest contribution to the American Chemical Society has been in opening the channels of communication. Our age could well go down in history as the first 'age of mass communication.' But, if we don't improve our methods, we may find ourselves hopelessly inundated in words, printed and spoken."

W. Albert Noyes, Jr., Dean of the Graduate School, University of Rochester, looked back to the turn of the century to find that relatively little basic research was then being done compared to that of Western Europe. He pointed out that World War I made it necessary for the United States to start a chemical industry along lines which had previously been supported in this country by imports. This expansion led to rapid expansion of scientific work in American Universities.

A change has taken place in chemistry in the United States since World War I, Dr. Noyes stated, and now organic chemistry in all its phases, including synthesis, natural products, physico-organic, seems to be outstanding in the United States. And, while the United States has every reason to be proud of its standing in organic chemistry, he said, there are also other countries with fine records, so that this field on a worldwide basis seems to be flourishing.

"Since World War II there has been a very pronounced shift of the American industrial economy into the sophisticated engineering exploitation of advanced scientific knowledge," Glenn T. Seaborg, Chancellor of the University of California, told the group. "The biggest impetus for this has come from the exacting requirements of the military preparedness effort, but the new technology which this effort has spawned has had widespread and crucial impact on the non-military as well."

AIR FORCE R&D REQUIRES WIDE CHEMISTRY RANGES

Scientists world-wide join contract effort

THE AIR FORCE Research and Development Command is active in basic and applied research of chemical problems that range from aromatic compounds to lunar vehicles and nuclear rocket engines. This work is under way with contracts of many titles on a world-wide basis. In the aggregate, these contracts would amount to many millions of dollars if they were totalled in some classification that could establish a satisfactory cut-off where chemistry begins and ends. Many of the companies, scientific institutions, or chemical engineers who perform this work have, in many cases, contracts in research and development in addition to those clearly identified by chemical titles. Without any attempt to find one of these contracts that is more typical than another, or to name one study more or less important than another, here are some of the contract titles selected at random:

Research rocket propellants, propulsions systems, fuels, rocket engine fuels, low temperature plasma jets, gamma phase irradiating test, stratosphere particle analysis, self generating gas pressure systems, thermal erosion of ablatives, advanced propellant, aircraft oxygen equipment, alloy panels, research lunar vehicles, effects of drugs, chlorophyll systems, liquid oxygen contamination, liquid oxygen systems, high pressure oxygen, liquid hydrogen, cryogenic fluids, monoxide refraction, metals and alloys, barium titanate, free radicals low temperature, molybdenum alloys, free radical solids, hydrogen peroxide, thermal concepts, reacting plasmas, develop coatings, research crystals, cryogenic gas, module glass fibers, hi temperature greases, storage of fluids, aersol scattering, neutron irridation, plastic molding powder, TNT composition, acute chronic toxics, capture gamma test, rocket borne camera, advance cooling techniques, develop properties of critical metals, carbon-dioxide reduction, hi strength metals, research titanium, pentaborone, monofuels, ozone desensitation, develop lubricants, flourine spill, liquid flourine, biophysics of flight, high speed photography, phosphine copolymers, moon radiation study, research synthetic carbides, artificial photosynthesis, and chlorides.

Some of the organizations may be working on vastly different problems within the same general title. So the title is indicative of where the work is going on rather than what is specifically being done. The search is for new fuels, new metals, and reactions in space for vehicles and man. It includes chemistry that will help the Air Force in its mission. Contractors doing this work are listed alphabetically as follows:

CONTRACTOR	LOCATION
Admiral Corporation	Chicago, Ill.
Advanced Kinetics, Inc.	Santa Ana, Calif.
Aerochemical Research Labs	Princeton, N. J.
Aerojet Engineering Corp.	Azuza, Calif.
Aerojet General Corp.	Sacramento, Calif.
Aerojet General Corp.	San Ramon, Calif.
Aeronautical Systems	Gleidale, Calif.
Aero Technical Corp.	Greenwich, Conn.
Agricultural Research	London, England
Agricultural University	Wageningen, Holland
Air Products Corp.	Allentown, Penna.
Air Reduction Sales Corp.	New York, N.Y.
Airkem, Inc.	New York, N.Y.
Alabama University	University, Ala.
Alcor, Inc.	San Antonio, Texas
Alfred University	Alfred, N.Y.
Allied Chemical Corp.	Los Angeles, Calif.
American Machine & Foundry Corp.	Pomona, Calif.
American Machine & Foundry Corp.	Chicago, Ill.
American Machine & Foundry Corp.	Alexandria, Va.
American Optical Company	Southbridge, Mass.
American Potash & Chemical Co.	Los Angeles, Calif.
American Physiological Society	Washington, D.C.
American Science-Engineering Service	Cambridge, Mass.
American Silicon Company	Hillside, N.J.
Anderson Laboratories, Inc.	Weston, Mich.
Anderson Physical Labs	Champaign, Ill.
Ansul Chemical Co.	Marinette, Wisc.
Applied Scientific Research	The Hague, Holland
Armour Research Foundation	Chicago, Ill.
Army Chemical Corps	Washington, D.C.
Army Chemical Corps	Fort Detrick, Md.
Army Chemical Corps	Edgewood, Md.
Army Engineers	Washington, D.C.
Army Engineers	Louisville, Ky.
Army Medical Lab	Washington, D.C.
Army Ordnance Department	Washington, D.C.
Army Ordnance Department	Dover, Del.
ARO Equipment Corp.	Bryan, Ohio
Art Metal Construction Co.	Jamestown, N.Y.
Atlantic Research Corporation	Alexandria, Va.
Atmospheric Research Group	Pasadena, Calif.
Atomic Energy Commission	Lemont, Ill.
Atomic Energy Commission	New York, N.Y.
AVCO Manufacturing Co.	Everett, Mass.
AVCO Manufacturing Co.	Wilmington, Mass.
Ball Brothers Research	Boulder, Colo.
Battelle Memorial Institute	Columbus, Ohio
Baylor University	Waco, Texas
Beech Aircraft Corp.	Wichita, Kan.
Bendix Aviation Corp.	Davenport, Iowa
Borg-Warner Corp.	Chicago, Ill.
Boston College	Boston, Mass.
Boston University	Boston, Mass.
Brandies University	Waltham, Mass.
Brown University	Providence, R.I.
Brush Beryllium Co.	Cleveland, Ohio
Bureau of Mines	Washington, D.C.
Bureau of Standards	Boulder, Colo.
Bureau of Standards	Washiigton, D.C.
Burke Relief Foundation	White Plains, N.Y.
Burlington Mills	New York, N.Y.
California Research Corporation	San Francisco, Calif.
Callery Chemical Company	Callery, Penna.
Carborundum Company	Niagara Falls, N.Y.
Carnegie Institute of Technology	Pittsburgh, Penna.
Catholic University of America	Washington, D.C.
Celanese Corp. of America	New York, N.Y.
Central Institute of Industrial Research	Oslo, Norway
Chromoalloy Company of America	New York, N.Y.
Clark, David N. Company	Worcester, Mass.
Clevite Corporation	Cleveland, Ohio
Columbia University	New York, N.Y.
Connecticut Hard Rubber Co.	New Haven, Conn.
Consolidated Vultee Corp.	Pomona, Calif.
Controls for Radiation, Inc.	Cambridge, Mass.
Cook Electric Co.	Chicago, Ill.
Cosmodyne Corporation	Hawthorne, Calif.
Cutler-Hammer Incorporated	Mineola, N.Y.
Diamond Alkali Co.	Painesville, Ohio
Dow Chemical Co.	Midland, Mich.
Dow Corning Corp.	Midland, Mich.
Duke University	Durham, N.C.
du Pont, E. I., de Nemour Co.	Wilmington, Del.
Eagle Picher Co.	Miami, Ohio
Eagle Picher Co.	Miami, Okla.
Eastern Nazarele College	Wollaston, Mass.
Electrochemische ABT	Munich, Germany
Esso Standard Oil Co.	New York, N.Y.
Fairchild Aircraft	Bay Shore, L.I., N.Y.
Firestone Tire & Rubber Co.	Akron, Ohio
Firewell Company	Buffalo, N.Y.
Fletcher Aviation	Pasadena, Calif
Flight Science Lab Inc.	Buffalo, N.Y.
Florida State University	Tallahassee, Fla.
Food Machinery & Chemical Corp.	San Jose, Calif.
Food Machinery & Chemical Corp.	Buffalo, N.Y.
Foote Mineral Co.	Philadelphia, Penna.
Fordham University	New York, N.Y.
Franklin Institute	Philadelphia, Penna.
Fulmer Research Institute	Buckingham, England
Galloway, G. W. Company	Arcadia, Calif.
Garrett Air Research	Los Angeles, Calif.
General Applied Science Lab.	Hempstead, N.Y.
General Electric Co.	Pittsfield, Mass.
General Electric Co.	Johnson City, N.Y.
General Electric Co.	Schenectady, N.Y.
General Electric Co.	Cincinnati, Ohio
General Electric Co.	Evendale, Ohio
Goodrich, B. F., Company	Akron, Ohio
Goodyear Tire & Rubber Co.	Akron, Ohio
Guertler, Dr. W.	Berlin, Germany
Gulf Research & Development Co.	Pittsburgh, Penna.
Gulton Manufacturing Co.	Metuchen, N.J.
Haloid Company, The	Rochester, N.Y.
Harshaw Chemical Co.	Cleveland, Ohio

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DR. FROLICH RETIRES AS SCIENTIFIC CHIEF OF THE CHEMICAL CORPS

Noted chemist and teacher plans first to take it easy

DR. PER K. FROLICH is retiring as Deputy Chief Chemcal Officer for Scientific Activities of the U. S. Army Chemical Corps. This tall, friendly man also serves as a vice-president of the Armed Forces Chemical Association and he is known wherever chemistry is the subject in industry, academic or government circles.

Dr. Frolich assumed his duties with the Chemical Corps six years ago and since that time his leadership has expanded the scientific activities of the Chemical Corps to an all-time high in peacetime.

Demands for the scientific expansion of Chemical Corps activities began when chemical weapons such as odorless lethal gases, biological agents which could ride the wind, incapacitating agents, and radioactive materials became known. Most of these weapons present changing problems of military defense, which required constant scientific study.

The American Chemical Society, which Dr. Frolich has served as president, began a nation-wide campaign to acquaint the public with the hazards of attack from these chemical weapons and took a lead in urging measures for civilian defense.

Under present plans, the Chemical Corps dollar expenditures will increase yearly for research and development upwards to an estimated $126 million. Dr. Frolich leaves active participation and leadership in the Chemical Corps at a time when scientific activities are on the increase as he has helped to plan.

Dr. Frolich said there are many things he wants to do of a personal nature, and one of them is to take it easy for a while. Later he may, he said, be available for consulting work.

Dr. and Mrs. Frolich live in Arlington, Virginia. They have two daughters. Miss Astrid Frolich is a physical education instructor at Wellesly College. Mrs. Robert B. Bachman, the other daughter, lives in Boston with her husband and three children.

Dr. Frolich, formerly Vice President for Scientific Activities of the Chemical Division of Merck & Co., Inc., manufacturing chemist, Rahway, N.J., assumed his present duties as Deputy Chief Chemical Officer for Scientific Activities and Chief Scientist of the Chemical Corps 1 December 1954.

A former president of the American Chemical Society, Dr. Frolich holds honorary doctoral degrees from Rutgers and Lehigh Universities. He has contributed some 60 papers to scientific publications, covering work in electro-chemistry, high pressure gas reactions, and other fields, and holds some 75 patents, alone or jointly with others. In 1930 he was awarded the Grasselli Medal by the American Section of the (British) Society of Chemical Industry for his studies on organic chemical reactions carried out at high pressure. During World War II he served on the executive committee of the Chemical Division of the National Research Council, and was professional consultant of the Office of Rubber Reserve, the Rubber Reserve Company, and the Office of the Rubber Director.

Dr. Frolich's activities in the American Chemical Society have included the following offices: Chairman of the North Jersey Section (1934), Chairman of the Division of Petroleum Chemistry (1938-40), Councilor-at-large (1940-41), President-elect (1942), President (1943), Director (1942-46), and member of the Committee Advisory to the Chemical Corps.

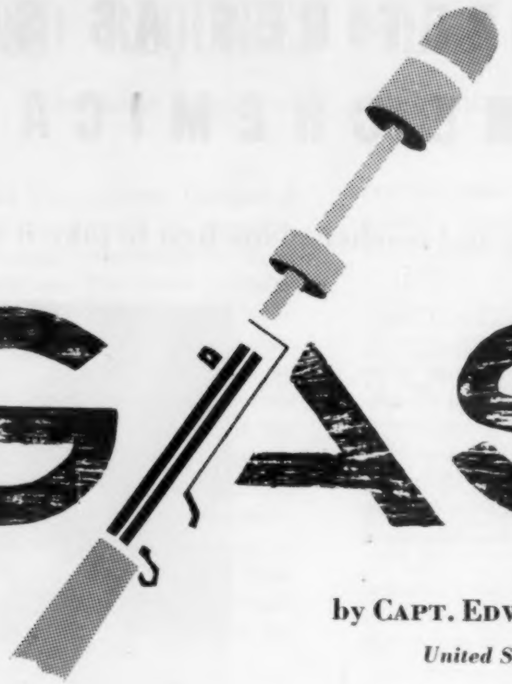
Dr. Frolich has served as a member of the Advisory Council to the Department of Chemical Engineering, Princeton University, as well as member of the Visiting Committee of the Department of Biology, Massachusetts Institute of Technology. He is now serving as a member of the Advisory Board of the Research Council of Rutgers University. He is representative of the U.S. Army on the Chemical Division of the National Research Council. Dr. Frolich is also a member of the American Institute of Chemical Engineers, the Society of Chemical Industry and the American Institute of Chemists. He belongs to the Chemists' Club and the Cosmos Club.

Born in Norway in 1899, Dr. Frolich received his technical education at Norway Institute of Technology, and then remained for a year as a teacher. Awarded an American-Scandinavian fellowship, he undertook graduate study at Massachusetts Institute of Technology, receiving an M.S. in 1923 and a Doctor of Science degree two years later. He became an associate professor at MIT, teaching and conducting chemical research until 1929, when he joined the Standard Oil Development Company of New Jersey, becoming Director of the Chemical Division of Esso Laboratories in 1936. He joined Merck & Co., Inc., in 1946.

In his present position, Dr. Frolich has immediate responsibility for Research and Development and Engineering activities throughout the Chemical Corps.

He retired 1 January 1961.

"GAS!"



by CAPT. EDWARD F. FITZGERALD

United States Marine Corps

"Whether or not gas will be employed in future war is a matter of conjecture, but the effect is so deadly to the unprepared, that we cannot afford to neglect the question."

General of The Armies
JOHN J. PERSHING

Unfortunately the Marine Corps and its sister services of today have not been heedful of Gen. Pershing's message; the Armed Forces of the US have disregarded the posibility of chemical gases as a weapon which we could utilize or which could be directed against this nation and her fighting forces. I venture to say that it would be catastrophic if gas alarms echoed throughout our barracks or on our bases, homes and abroad, for reasons other than drill or rehearsal. We are not prepared for gas warfare nor have we developed our chemical weapons to a sufficiently high standard which would permit us to attack with gas or to retaliate against a determined enemy who chose to utilize gas. The effect which gas would have had against our forces during WWII and in Korea leave me somewhat timorous.

Gen. Omar Bradley made the following remarks concerning the possible use of chemicals during WWII:

"While planning the Normandy invasion, we had weighed the possibility of enemy gas attack and for the first time speculated on the probability of his resorting to it. . . . I reasoned that Hitler, in his determination to resist to the end, might risk gas in a gamble for survival. When D-Day finally ended without a whiff of mustard, I was vastly relieved. For even a light sprinkling of persistent gas on Omaha Beach could have cost us our foothold there." The same remarks could well be applied to the Inchon landing and the results even more disastrous if nerve or blood gas had been used.

Why this apathy on our part towards gas, a weapon which—when analyzed with an open mind, one free of hysteria and exaggerated emotion—proves to be one of our best potential instruments of war? I make this assertion knowing full well that there are many men and women who will level a multitude of charges at me because of my seemingly immoral, cruel, unsportsmanlike tenets of war. I stand prepared to face the whole gamut of vindictiveness for I sincerely believe that this nation is attempting to bury its head in fear of gas as does the fabled ostrich when an unpleasant situation presents itself. The accusations are certain to be heard, for the anti-gas propagandists have been exceedingly successful in building a false picture of chemical warfare and stirring the inner fears of mankind. No military subject is so litle undersood and has suffered as much vilification as gas. Sensationalistic writers have published literary condemnations of gas warfare-condemnations devoid of scientific fact. However, these writers are not alone for they have been joined by ultra-pacifists and military leaders who permit their imagination to run rampant as they expound on the subject of gas warfare. Winston Churchill has aptly described the ideas of these men as "terminological inexactitudes."

My purpose in writing this thesis is to separate the truth of chemical warfare from the sensationalism and fantasies which prevail today concerning this subject. It is not my intention to become engaged in an academic discussion or debate as to whether gas is a humane weapon of war, although in later pages I will dwell briefly on this aspect. Those who argue that being burned alive by napalm, torn limb from limb by high explosives, or destroyed by nuclear radiation or its intense heat are more humane ways of death, are not facing reality, nor is their criteria in judgment of weapons graphic or valid. My basis in determining humaneness of weapons, if they must be judged in such a light, is the degree of suffering, the percentage of deaths and disfigurements and the aftereffects. It is an established fact that the more "humane" an explosive weapon becomes, the less effective it there-

fore is. However, I will show that those who strive for humaneness in armed conflict would best and logically become advocates of the use of chemicals in war, for gas is the most humane weapon we presently possess and can develop. War is the searching out and destroying of the enemy and in itself is the negation of humanity. A nation facing possible annihilation must consider in what areas and with what weapons it best can strike. Any other concept is delusion and fallacy. A nation at war or facing armed conflict cannot afford to make any military decisions based on such premises. Degrees of humanity best fade away in the light that war is a grim contest between states for national existence and it is not to be viewed as a sport confined to an arena. In view of this, there can be little room for any argument that a weapon is humane although if, for some, this condition must be met, gas does satisfy the requirement well.

There appears to be an attitude throughout the Armed Forces today that the only weapons which can be effective in this age of push buttons and electrons are those which still are on the drawing boards of our scientists and that this nation would be taking a step backward if any development was made on weapons utilized in the past. Such is the case with gas—many believe that since it was primarily a WWI weapon, this is evidence that it has no value in today's thoughts, and that any values which chemicals may have had, have been replaced more efficiently by nuclear weapons, electronic equipment and guided missile. The supposition above, coupled with the fact that gas was not used during WWII, has overshadowed the picture of actual warfare as it will be fought for many years to come. This apathy concerning gas must not be permitted to continue and to flourish, for if it does this nation will be exposing its Achilles heel at which our enemy will aim his arrows.

The fact that gas was not used during WWII was not due to any humaneness or high moral fiber which permeated the world at that time. The ovens of Dachau and the Bataan march were the true indications of how the war was pursued then and how it will be fought again. Nor was it because of any international leagues or agreements that this weapon failed to see employment during WWII, for history has taught us well the value of a treaty or a "piece of paper."

The US has agreed not to employ chemical weapons with but one country—Panama. There is in existence today no other concordat which prohibits the use of gas on the part of the US. All attempts to place the name of this country on such agreements with European and Asiastic nations were defeated or never ratified by Congress or the ruling bodies of other countries. The nations which did choose to sign weapon-limitation pacts saw the value of such concerts when Italy used mustard gas against the barefoot army of Ethiopia. Both nations had affixed their signatures to an anti-gas pact the very month Italian fliers sprayed the flanks of the battlefields on which hey were engaged. It is no secret that nations have always lacked the willingness to sacrifice weapons and military advantages in the interest of disarmament. The Ethiopian War was only added proof of this international attribute. No, gas was not used in WWII or in Korea due to any moral reasons or international agreements but rather because it

CAPT FITZGERALD presently CO, MD, USS *Los Angeles*, wrote this article because he believes the Armed Forces are neglecting a weapon "which could change the tide of any war." He was commissioned in Sept. '52 via OCC after graduating from Dartmouth College. As an infantry officer in Korea (May '53 to Apr '54) he served as a platoon leader, 60mm mortar section leader, and Bn S-4. Subsequently he attended the Artillery School at Ft. Sill and commanded a Btry at 29 Palms.

was not considered tactically advantageous to our enemies at the time. Vast supplies of gas were found in Germany and Japan after their defeat in 1945—an indication that if the proper opportunity presented itself gas might have been used.

For this Nation to agree with any major nations that gas will not be used by us in any future war would be sheer folly and would be a basically unsound military decision. Any such treaties or agreements would permit a potential enemy nation to limit our strength and to capitalize on his weaknesses. If it was to be accepted that we would use toxic gas only in rataliation we would be making a basic military decision on moral grounds only and it would be an unsound decree as such. Such an approach to chemical weapons would permit an enemy to choose the weapons he is best suited and prepared to fight with. Simply because we have engaged in conflict with a nation which has no suitable chemical industry to supply its

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GAS!

(Continued from page 15)

needs does not necessarily mean that we should not or cannot utilize gas as a weapon. We have the best chemical industry in the world today and any agreements prohibiting the use of gas merely tie our hands and leave us at the mercy of the unscrupulous. Our superior chemical productiveness and scientific technology are our best weapons against the communistic masses.

The history of gas warfare dates back two thousand years when burning pitch was used to gain a military advantage. It was used frequently by the Roman legions and burning sulfur became one of the primary weapons of any siege. During the war which drove a temporary wedge between the North and South there appeared a number of advocates of chemical warfare. There is little doubt that had their ideas been adopted, the war would have been less lengthy, and perhaps fewer casualties would have occurred. The world witnessed the most widespread use of chemical weapons shortly after the Germans released the gaseous clouds against the entrenched Allies at Ypres in April of 1915. The use of this weapon resulted in confusion among the ranks of the thousands of men who manned the Allied lines. The 1500 casualties, a result of the surprise, unpreparedness and lack of gas discipline among the troops, gave the Germans a potential tactical advantage the like of which they would never have again. The effectiveness of this new weapon was underestimated by the Germans and they failed to realize the opportunity which was before them and that the doors to Paris were then open wider than ever before. Shortly after this chemical attack the Allies again closed these portals and never again were they opened as they were that fateful day of April. Throughout the remainder of WWI the Allies resorted to gas weapons to strike at the Germans and to inflict casualties on an enemy which had been driven into trenches and tunnels by bullets and high explosives. Gas was not seen again after WWI until the Italians used it in Ethiopia in 1936 and the Japanese found chemicals to be such an effective weapon against the Chinese in the Thirties.

It was during the years which followed WWI that gas was the topic of heated discussions at the international conference tables. The nations which had fought the "war to end wars" were now attempting to limit the weapons of the next armed conflict. These conferences brought with them the pacifists, pseudo-militarists and sensationalists who condemned gas as being the weapon of the devil. Many of these men had failed to see the real intent of British propaganda in 1915-1917 concerning chemicals—propaganda designed not to show gas as it truly was but to bring world opinion against the Huns. The Allied accusations that the Germans violated the Hague Conference of 1899 by using gas was in itself a falsehood which was promulgated by the Allies. The few men who attemped to inject factual tactical and medical statistics concerning gas used during WWI were shouted down. The many conferences failed to unite the Allies in agreeing which weapons would be utilized in future wars and as the delegates returned to their capitals it was evident that few countries were willing to limit themselves to specific classes of weapons. The US had not affixed her signature to any weapon limitation agreements which included any of the major nations of the world.

The unlimited advantages of chemical warfare practically insure that another war in which gas will be utilized is not a mere dream. Nations faced with survival must turn to the weapons which will provide victory with the least expense in iterms of both men and material. The development of "modern" destructive weapons has brought forth a number of men who speak strongly in favor of the use of chemicals in war. They argue that gas would provide the ways and means to a military victory at the conclusion of which casualties would not be counted in figures of millions of deaths and countries would not be faced with smoldering ruins to rebuild at costs which exceed that of the war itself. Some foresee that nations such as the US cannot economically continue to carry the burden of financing a rehabilitation program at the conclusion of each armed conflict. No longer is military victory enough—economic stability must be provided as well.

Military effectiveness should be the criterion of all weapons, conventional, chemical, nuclear or otherwise; ethical considerations are not of primary concern. As the purpose of all weapons is to disable or destroy the enemy's potential to wage war, then it holds that the more swiftly, surely and economically that this result can be accomplished, the better the weapon. Disabling the enemy does not necessarily mean that the enemy's armies and men must be blown to pieces or his country ravaged. The purpose of war is not to massacre but to merely subdue the enemy. No greater degree of force should be employed in any war than is necessary to achieve victory. Ruthless destruction of life and property is not a necessity of armed conflagration nor is it even warranted when other means present themselves. Any other concept of war is not a valid one.

Chemicals provide an army with the weapons which can bring an enemy to submission without killing or maiming the youth of the country—the very men who are so sorely needed when polticial adjustments to insure future peace are made. Gas offers us the means by which we can select our targets, thereby confining it to the battlefield, if we so desire. By choosing the type of gas we wish to employ we can temper and adjust it either to kill, harass or temporarily disable an enemy. Our selection varies from simple lacrimation to quick death. We can wage such a war without destroying the economy of a nation. A nation could emerge from a war and not be faced with the task of rebuilding its churches, homes, factories and without the loss of cultural monuments which could never be replaced. More importantly, the man who is gassed comes out a whole man, unmangled by gun powder if the proper selection of the chemical is made. A man re-enters civilian life ready to shoulder his portion of responsibility in a new nation.

Gas has the further advantage of being a weapon which can be controlled in any weather, for chemicals are governed by specific laws of physics. Winds of determined speed, temperature and humidity all can be measured before the gas is released and the user knows almost certainly what the result will be. Gas is able to "shoot" around corners, inside buildings; it seeks low ground, goes in foxholes into which bullets have driven the enemy; it is effective for as long as desired—the length of time is limited only by the choice of gas and the amount released. Whereas high explosives provide only a one-time, one-shot effect and great accuracy is needed to be effective, such is not the case with gas. Furthermore, a bullet is useless after it strikes the enemy, whereas gas has a continuous effect. It stays active even after having in-

flicted a casualty. Gas, unlike a bullet, follows no narrow trajectory; it permeates the air, penetrates tanks and pillboxes and overcomes all incidental obstacles to stalk its quarry relentlessly.

Chemicals satisfy two principles of war—surprise and simplicity—very well. In the offensive our forces could utilize gas by harnessing the enemy and causing him to mass and prepare in his defenses under the handicap of protective equipment. We could prevent the enemy from occupying strategic ground by using a persistent gas on that particular area, timing its effectiveness so that upon our arrival our troops could occupy the same terrain. Sealing off our flanks by use of gas would be a commonly accepted tactic and this woud permit greater concentration to the front and fewer men would be needed to give all around defense.

The employment of a gas provides the means to neutralize areas and causes an enemy to evacuate and abandon materials which could be destroyed or used by advancing armies. True, high explosives in destroying materials weaken an enemy but in turn prevents their use by others.

In the defense chemicals can prove to be extremely desirable weapons. With gas, avenues of approach can be sealed off by persistent agents. An enemy attempting to utilize the approach must then either mask or don protective equipment which would slow and hinder his movements and make him more susceptible to other weapons. Gas gives us this advantage without the time consuming effort of laying barbed wire and mines. It would not hinder our advance as to mines and wire if we choose to move forward after the gas becomes ineffective.

Areas which command views of friendly units and front lines can be made untenable by chemicals. The savings in lives would have been tremendous if gas had been used on some of the Korean hills and the Chinese prevented from occupying this high ground. Again, gas could have been utilized to capture prisoners of war simply by selecting a type of gas which would make a man unconscious for a period of time and permit our patrols to move forward to carry him back for interrogation.

When opposing forces reach a stalemate due to equal fire power there can be no advance except by numerical superiority. Gas would prove to be the weapon which would restore mobility to the situation. The force which resorted to this weapon first would gain the tactical advantage which could well spell victory. This consideration becomes of great concern and more poignantly important to us when we consider that the nations opposing us today are those very countries which have this numerical superiority which could prove so helpful.

Gas Casualties WWI

Chemical warfare provides the advantage of permitting the user to select the type of casualty he desires. This advantage offers the possibility of selecting a gas which would cause casualties only and thus engage a larger percentage of manpower in the care of these injured. Men put out of action are liabilities to the effectiveness of any military organizatiton; every casualty would engage other personnel in caring for him and thus keep these potential fighters from the front lines where they could take up arms against our forces.

The value of gas is even more striking when we review the statistics which came out of the last major war in which chemicals were used. WWI figures—free now of hysteria, the desire or necessity to falsify them in an effort to appease specific groups and made more valuable by the lapse of time we have had to appraise and study the after effects of the chemicals used—give us valuable information.

From the time the Germans launched their first chemical attack to the Armistice, chemical agents accounted for one-third of the 274,000 casualties suffered by the American Expeditionary Force: 37 out of every 100 US casualties. These are very remarkable results when we note that chemical warfare was not introduced until the end of the first year of the war, it then went through a period of experimentation for the next two years and was not developed to a degree even remotely approaching its possibilities until almost the last year of the war when mustard was utilized in July 1917. New methods of delivery such as the airplane, missiles and artillery would make these figures even more convincing. Out of the American chemical casualties, death resulted in only 1.5 per cent, while on the other hand, 28 per cent of those casualties caused by high explosives died. In other words, a man had a 12 times better chance of living if struck down by gas. These figures become even more interesting when we learn that the Germans had a mere 6,000 troops assigned to chemical units throughout the war. For a unit of such a small size, its record of causing casualties is indeed a fine one.

Economically, too, gas proves its worth when we discover that there was one casualty for every 60 pounds of chemicals used. For high explosives to attain the same results 500 pounds of HE were required. The cost of gas is far less than that of HE and the results far better. In support of these statements I offer for consideration the results of a study conducted shortly after the

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GAS!

(Continued from page 17)

Iwo Jima invasion. In February 1945 Iwo Jima was one of the last milestones of resistance on the road to Tokyo. Its 8 square miles were honey-combed with tunnels, caves, and bunkers which provided a high degree of protection on a 24-hour basis to the 22,000 Japanese defenders. Six thousand tons of HE bombs were dropped in pre-invasion bombardment and 8,000 tons of HE were fired into defensive positions during the 2 days preceding the assault. These 14,000 tons of explosives delivered as preparatory fire actually had little effect on the defense capabilities of the troops holding the island. It therefore became necessary to storm Iwo the expensive way—24,000 American casualties. Data available at the time of the invasion gave reasonable assurance that approximately 5,000 tons of mustard gas, properly employed, would have killed or incapacitated a major portion of the defenders and would have permitted our forces to go ashore essentially unopposed. I need not dwell on comparisons of the cost of mustard and HE, and there can be no price tag on 24,000 casualties.

Medical records of both Great Britain and the United States conclusively indicate that the after effects of gas are far less horrible than those of other weapons. The much circulated stories that men who were victims of gas were prone to become bedridden with tuberculosis have no sound medical basis, for the truth is that the percentage of lung disease in men untouched by chemicals is comparable in every respect with those soldiers who were gassed. The vast majority of veterans confined to government medical centers are victims of high explosive injuries—not chemical. The same situation holds true with those confined to psychopathic wards—they are predominantly "shell-shocked" victims of high explosives—not gas. Furthermore, statistics indicate that those men who were gassed and who required hospitalization spent 50 per cent less time in the hospitals than the victims of high explosives. Gas, while it can cause casualties, permits a vast percentage of men to return to normal life as whole men free from artificial limbs and metal plates.

The medical statistics of WWI are proof that if any weapon of war is humane, gas is that weapon. Paragraphs above have indicated my opinion that humanitarian considerations in weapons should not be the primary concern of those who bear the responsibility of preparing this Nation for war. However, in an attempt to bring gas into the proper perspective which it deserves I find I must defend chemicals in part in the very light I find objectionable. If I am successful in helping to raise gas warfare to its proper level by showing that it is not a dreadful weapon then I am not reluctant to defend it on the basis of humanity.

The humaneness of gas is indicated in part by the movement in this country to adopt gas as the means of inflicting capital punishment upon our criminals and the increased use of gas by law enforcement agencies to quell civil disturbances and riots. Surely if gas was the cruel, barbaric weapon many wish us to believe, then civilized people would not resort to it as a means of controlling their own neighbors and countrymen.

Are we as a force prepared to enter combat to meet an enemy which utilized a chemical weapon? I fear that we are not and that, in spite of the high discipline in the Marine Corps, we would have many unnecessary casualties which could be prevented if we undertake a realistic approach to the possibility of gas attack. Like most Americans we labor under the conception that gas is a weapon of our forefathers and that if we do not think about or prepare for a chemical war, then one will not occur. It is unnecessary to explain the folly of such rationalization. We have an unjustified fear of gas because to many it is a mystery which is not understood. Out of our ignorance an unjustified fear has grown. Gas has become a subject most Americans do not wish to discuss. We as a Nation would do well to apply the words of Franklin D. Roosevelt to the subject of chemical warfare—"the only thing we have to fear is fear itself."

There is strong reason to believe that there are nations today which are giving gas another look. They base this new approach to this controversial weapon upon the fact that their national budgets will not permit extensive development of expensive nuclear weapons and costly guided missiles. Gas is one weapon which can be mass produced at comparatively low cost and this in itself is appealing to many nations which must provide a defensive system on depleted treasury funds. They base their new interest on the premise that in armed conflict during which nuclear weapons are utilized against them they too must find a weapon which outmodes conventional high explosives. Further, if fear of retaliation on the part of the major powers prevents the use of atomic weapons, these smaller countries believe gas may be the alternative and that they will be in an advantageous position in the event of an attack.

The time has come when we must approach the subject of gas warfare and the possibility of a chemical attack with a realistic outlook—one which is based on mature military thinking, void of fear and hysteria. We must include gas training in our military maneuvers; condition our troops with the fact that they may be forced to wear gas masks; teach that with practice the handicap which is an inherent disadvantage of any mask can be overcome and that they as fighting men can become more efficient in work and in war while donning such a mask. It would be wise to require that our troops wear protective masks for long periods of time—for periods as long as a day. We must utilize harassing chemicals, both the tear and vomiting gases, against our own troops in training periods, maneuvers, demonstrations and at unexpected times to condition them to gas, to instill speed in detection and in protecting themselves, to teach them through experience that gas used against disciplined troops is not certain death. The use of vomiting gases will make many men sick for a short period but such a vivid experience would pay tremendous dividends if the gas were ever used in actual combat. We must teach first aid and individual protection for, unlike conventional weapons, gas does not spill blood to warn of injury and even if a man becomes a victim of gas he need not necessarily be required to lay down arms to receive medical attention. It will be necessary to teach our troops that the value of chemicals is not derived from their deadlines per se or casualty producing effects, but rather from the direct influence they have upon tactical situations by affecting military units as a whole rather than individuals. However, success in preventing entire units from being effectively removed from combat lies solely with each individual and how he responds when the gas alarms are sounded or when he detects the presence of chemical agents.

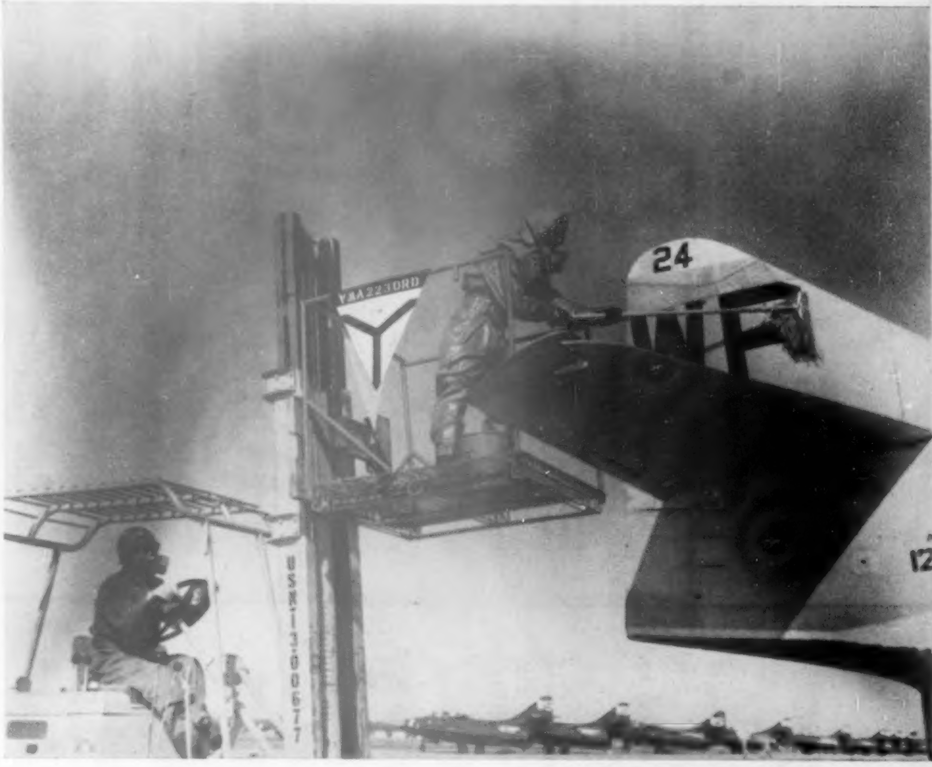
We have no guarantee that gas will not be used again; it is too effective a weapon for all nations to simply discard as obsolete and outmoded. We have had proof that nations who choose to use chemical

will not consider any agreements concerning this weapon. While I do not maintain that gas could or would make any other weapon obsolete, it in itself is far from being antiquated and replaced as an instrument of war. If our government does choose to adopt a policy that this Nation will not resort to gas, our best insurance against it being used against us is that we study it, develop it and train for an armed conflict in which chemicals will see use again.

The Marine Corps perhaps will be the first military organization to be gassed if an enemy does make the decision to utilize this weapon. This assumption is based on the fact that Marines generally are the first troops to be committed in any war and the enemy would use his gas then to give him the initial military advantage before nuclear weapons may be used.

We must be prepared. Facing this possibility it would be wise for us to re-examine our present training program to include a realistic approach to chemical warfare and the consequences of such a war. We must be ready to continue aggressively in combat if gas is used against us and we must also be prepared to affectively deliver chemicals upon our enemy.

Marine carrying a light flame thrower and wearing experimental atomic, biological, and chemical (ABC) protective clothing looks like he might have dropped in from another world.



Decontamination Drill at El Toro Marine Corps Air Station.

Marine uses a radiac instrument to take a reading to determine the extent of radiological contamination of jeep.

MOVE OUT!—Marines prepare to charge an "objective" seconds after an explosion at the Atomic Proving Grounds, Yucca Flat, Nevada.

UNIVERSITY CHEMISTS PURSUE ARMY'S BASIC RESEARCH

Scientists puzzle with chemical problems both in U. S. and Europe

Basic chemical research is being carried on in the Army by 220 contractors, most of them universities located in the United States or Western Europe. The Office of Defense Research and Engineering, Department of Defense, describes basic research as work without a specific pre-determined application. It is a fact search for information needed by the Military. This is the reason that these contracts are with other Army Agencies than the Chemical Corps.

Chemical Corps contracts in research are directed toward an immediate end or use in the military system. Lieut. General Trudeau's compilation of Army R&D contracts shows that basic chemical research is being done as follows:

CONTRACTOR	TASK TITLE	ARMY AGENCY
The University Birmingham 15, England	Analysis of Organic Compounds on the Submicro Scale	Army R&D APO 757, New York, N.Y.
University of Minnesota Minneapolis, Minn.	Formation of Microcrystalline Precipitates	Army Ordnance Research Durham, N.C.
Watertown Arsenal Laboratories	Electro-Analytical Chemistry of the Metallic Elements	Ordnance Research Watertown Arsenal
U.S. Army QM Res. & Eng. Command, Natick, Mass.	Study of the Composition and Structure of Matter	QM R&E Labs Natick, Mass.
Rice Institute Houston, Texas	Synthesis and Isolation of Compounds from Natural Products	QM R&E Labs Natick, Mass.
Technological Univ. of Delft Delft, Holland	Effects of Ultraviolet Light on Nucleic Acids	Army R&D APO 757, New York, N.Y.
Postgraduate Medical School London W. 12, England	Adrenal Function Changes in Disease States	Army R&D APO 757, New York, N.Y.
University College Galway, Ireland	Structure of the Phycobilins	Army R&D APO 757, New York, N.Y.
Evans Research & Development Corp., New York, N. Y.	Synthesis & Isolation of Compounds from Natural Products	QM R&E Center Labs Natick, Mass.
Institute of Biochemistry University of Uppsala, Sweden	Separation Methods for Biologically & Medically Important Substances of Large Molecular Weight	Army R&D APO 757, New York, N.Y.
University of Sheffield Sheffield, England	Primary Photochemical Reaction in Photosynthesis	Army R&D APO 757, New York, N.Y.
Istituto di Chimica Generale e Inorganica dell' Universita di Roma Roma, Italia	Chemisorption & Catalysis on some Oxyde & Sulphyde Semiconductors	Army R&D APO 757, New York, N.Y.
Royal Holoway College University of London Surrey, England	Studies in Boron Chemistry	Army R&D APO 757—New York, N.Y.
University of Southampton Southampton, England	Complex Compounds of the Titanium, Vanadim and Chromium Groups	Army R&D APO 757, New York, N.Y.
Technical University of Vienna, Vienna, Austria	Inorganic Chlorides and Oxychlorides as Solvents	Army R&D APO 757, New York, N.Y.
Istituto di Chimica Generale dell' Universita di Palermo Via Archirafi 26, Italy	Thermodynamics of the Interaction of Bisacetyl-bisbenzoylhydrazone-nickel (II)	Army R&D APO 757, New York, N.Y.
Birbeck College University of London London W. C. 1, England	Alkyl and Aryl Derivatives of the Phosphonitrilic Halides	Army R&D APO 757, New York, N.Y.
Polytechnic Inst. of Brooklyn Brooklyn, N. Y.	Thin Films of Ferromagnetic Oxides	Army Signal USASRDL Fort Monmouth, N.J.
University of Cincinnati Cincinnati, Ohio	Nitrogen Analogs of Alkanes and Alkenes	Ordnance Research Durham, N.C.
Clark University Worcester, Mass.	Dipole Moments of Metal Chelate Compounds	Ordnance Research Durham, N.C.
University of Illinois Urbana, Illinois	Reactions of Nitrogen (II) Oxide	Ordnance Research Durham, N.C.
University of Illinois Urbana, Illinois	Electrochemistry of Fused Salts	Ordnance Research Durham, N.C.
Massachusetts Institute of Technology, Cambridge, Mass.	Chemistry of Boron	Ordnance Research Durham, N.C.
University of Minnesota Minneapolis, Minn.	Acid-Base Chemistry in Nonaqueous Solvents	Ordnance Research Durham, N.C.
University of Minnesota Minneapolis, Minn.	Boron Hydrides, Boron Halides and Related Compounds	Ordnance Research Durham, N.C.
Oklahoma State University Stillwater, Oklahoma	Transition Metal Chlorides in Aqueous Hydrochloric Acid Solutions	Ordnance Research Durham, N.C.
University of Pennsylvania Philadelphia, Penna.	Physical Properties of Metal-in-Amine Solutions	Ordnance Research Durham, N.C.
University of Pittsburgh Pittsburgh, Penna.	Reactivity and Molecular Constitution of Some Metal Hydrides in Solution	Ordnance Research Durham, N.C.
Purdue Research Foundation Lafayette, Indiana	The Complex Hydrides	Ordnance Research Durham, N.C.
University of Washington Seattle, Washington	Nonclassical Aromatic Systems	Ordnance Research Durham, N.C.
West Virginia University Morgantown, West Virginia	Metal Ion Complexes of Oxygen Substituted Amines	Ordnance Research Durham, N.C.
University of Wisconsin Madison, Wisconsin	Fluorine Chemistry	Ordnance Research Durham, N.C.
Queen Mary College University of London England	Electron-Spin Resonance Study of Oxidation Reactions	Army R&D APO 757, New York, N.Y.
University of Leicester Leicester, England	Arylsilanes and Aromatic Reactivity	Army R&D APO 757, New York, N.Y.
Kungl. Tekniska Hoegskolan Institutionem fur Orgnisk Keml Stockholm 70, Sweden	Heartwood Constituents of Conifers	Army R&D APO 757, New York, N.Y.
Queen's University Belfast, United Kingdom	The Mechanism of the Oxidation of Organic Amines	Army R&D APO 757, New York, N.Y.

CONTRACTOR	TASK TITLE	ARMY AGENCY
Instituto Chimica Industriale University of Bologna Bologna, Italy	Spectroscopic Study of Aromatic Sulfur and Selenium Compounds	Army R&D APO 757, New York, N.Y.
University of Southampton Southampton, England	A Mechanistic Study of the Reactions of Epoxides with Nucleophiles	Army R&D APO 757, New York, N.Y.
Istituto di Chimica Dell' Universita di Trieste Trieste, Italy	Low Energy Free Radicals and Unstable Organometallic Compounds	Army R&D APO 757, New York, N.Y.
RCA Laboratories Somerville, N. Jersey	Primary Cells Utilizing Organic Compounds as the active Components	Army Signal USASRDL Fort Monmouth, N.J.
U. S. Army Signal R&D Lab. Fort Monmouth, N. J.	High Polymer Research	Army Signal USASRDL Fort Monmouth, N.J.
U. S. Army Signal R&D Lab. Fort Monmouth, N. J.	Electronically Functional Organic Materials	Army Signal USASRDL Fort Monmouth, N.J.
University of Akron Akron, Ohio	Degradation Studies on Condensation Polymers	Army Signal USASRDL Fort Monmouth, N.J.
Princeton University Princeton, New Jersey	High Polymer Research	Army Signal USASRDL Fort Monmouth, N.J.
University of Pennsylvania Philadelphia, Penna.	Synthesis of Block and Graft Polymers	Army Signal USASRDL Fort Monmouth, N.J.
Applied Physics Div. USASDRL Fort Monmouth, N. J.	Photographic Processing Res— Problem 1. Investigation of methods of increasing the effect film speed of conventional films	Army Signal USASRDL Fort Monmouth, N.J.
Applied Physics Div. USASDRL Fort Monmouth, N. J.	Photographic Processing Res. Problem 2—Investigation of combined Development and Fixation with Monobaths	Army Signal USASRDL Fort Monmouth, N.J.
Applied Physics Div. USASDRL Fort Monmouth, N. J.	Performance Valuation—Study of Aerial Films	Army Signal USASRDL Fort Monmouth, N.J.
General Aniline & Film Corp. Binghamton, New York	Photographic Receptor Research Prob. I—Investigation of the Photo-polymerization Process	Army Signal USASRDL Fort Monmouth, N.J.
U. S. Army Signal R&D Lab. Fort Monmouth, N. J.	Photographic Research-Receptors	Army Signal R&D Fort Monmouth, N.J.
Brandeis University Waltham, Mass.	Intraanular Resonance Effects in Ferrocene	Army Ordnance Research Durham, N.C.
Brown University Providence 12, R. I.	Reaction of Basic Reagents with Aromatic Substrates	Army Ordnance Research Durham, N.C.
Brown University Providence 12, R. I.	Oxyanion Systems	Army Ordnance Research Durham, N.C.
University of California Berkeley, Calif.	Intermediate Structures Occurrings in Rearrangement, Substitution & Elimination Reactions	Ordnance Research Durham, N.C.
University of California Berkeley, Calif.	**The Chemistry of Allied Compounds**	**Army Ordnance Research Durham, N.C.**
University of California Berkeley, Calif.	**Mechanism of Substitution and Rearrangement Reactions**	**Ordnance Research Durham, N.C.**
Carnegie Institute of Technology Pittsburgh, Penna.	**Polymeric Phosphorous-Nitrogen Compounds**	**Army Ordnance Research Durham, N.C.**
University of Cincinnati Cincinnati, Ohio	**Relation between Structure and Reactivity of Organic Compounds**	**Army Ordnance Research Durham, N.C.**
University of Colorado Boulder, Colo.	**Bridged Polycyclic Compounds**	**Army Ordnance Research Durham, N.C.**

CONTRACTOR	TASK TITLE	ARMY AGENCY
University of Connecticut Storrs, Conn.	Transannular Reactions of Free Radicals	Army Ordnance Research Durham, N.C.
Cornell University Ithaca, N. Y.	Fluorine Free-Radical Chemistry	Army Ordnance Research Durham, N.C.
Carnegie Inst. ol Technology Pittsburgh, Penna.	Electronic Effects in Base Catalyzed Elimination Reactions	Army Ordnance Research Durham, N.C.
Duke University Durham, North Carolina	Fluorination of Organic Compounds	Army Ordnance Research Durham, N.C.
Duke University Durham, North Carolina	Certain Reactions of Organometallic Compounds and Some Cyclizations	Army Ordnance Research Durham, N.C.
Florida State University Tallahassee, Fla.	Studies in Pyrrole Chemistry	Army Ordnance Research Durham, N.C.
Florida State University Tallahassee, Fla.	The Cyclopropyl Radical	Army Ordnance Research Durham, N.C.
Georgia Technical Res. Inst. Atlanta, Georgia	Photochemically Induced Diels-Alder Reactions	Army Ordnance Research Durham, N.C.
Georgia Tech Research Inst. Atlanta, Georgia	Divalent Carbon Derivatives as Reaction Intermediates	Army Ordnance Research Durham, N.C.
University of Illinois Urbana, Illinois	Diazo Reactions and Certain Ketonic Rearrangments	Army Ordnance Research Durham, N.C.
University of Illinois Urbana, Illinois	Nucleophilic Attack of Aromatic Rings by Organo-Metallic Compounds	Army Ordnance Research Durham, N.C.
Illinois Inst. of Technology Chicago, Illinois	Multiple Structure - Reactivity Correlations	Army Ordnance Research Durham, N.C.
Indiana University Bloomington, Indiana	Synthesis and Reactions of Unsymmetrical Disulfides and Disulfones	Army Ordnance Research Durham, N.C.
State University of Iowa Iowa City, Iowa	Structure of Olefin-Metal Complexes	Army Ordnance Research Durham, N.C.
State University of Iowa Iowa City, Iowa	The Complexes of Halogens with Organic Compounds	Army Ordnance Research Durham, N.C.
State University of Iowa Iowa City, Iowa	Polarographic Behavior & Electrolytic Reduction of Organic Compounds in Dimethylformamide	Army Ordnance Research Durham, N.C.
Johns Hopkins University Baltimore, Md.	Reactions of Enols	Army Ordnance Research Durham, N.C.
Johns Hopkins University Baltimore, Md.	Synthesis and Certain Reactions of Nitroalkanes and Nitroamines	Army Ordnance Research Durham, N.C.
University of Kentucky Lexington, Kentucky	Pyrolysis of Some Cycloalkano Pyrroles	Army Ordnance Research Durham, N.C.
Louisiana Polytechnic Inst. Ruston, Louisiana	RLi-Induced Ring Closure of Trityl Methyl Ether	Army Ordnance Research Durham, N.C.
University of Louisville Louisville, Kentucky	1, 2, 3,-Triazoles, 1, 2, 4,-Triazoles: Related Oxa-and Thiadiazoles & Tetrazoles	Army Ordnance Research Durham, N.C.
Massachusetts Institute of Technology, Cambridge, Mass.	**Oxidation of Nitrogen Compounds: Chemistry of the Amine Oxides**	**Army Ordnance Research Durham, N.C.**
Michigan State University East Lansing, Mich.	**Acylation of Cyclopropanes**	**Army Ordnance Research Durham, N.C.**
University of Minnesota Minneapolis, Minn.	**Organo-Sulfur Compounds**	**Army Ordnance Research Durham, N.C.**

CONTRACTOR	TASK TITLE	ARMY AGENCY
University of Minnesota Minneapolis, Minn.	Investigations into Cellulose and Related Compounds	Army Ordnance Research Durham, N.C.
Northwestern University Evanston, Ill.	The Formation, Structures and Reactions of Sultones	Army Ordnance Research Durham, N.C.
Northwestern University Evanston, Ill.	Unstable Organic Species	Army Ordnance Research Durham, N.C.
Ohio State University Columbus, Ohio	The Role of Steric Factors in Organic Chemistry	Army Ordnance Research Durham, N.C.
Ohio State University Columbus, Ohio	Nitrated Carbohydrates	Army Ordnance Research Durham, N.C.
Northwestern University Evanston, Illinois	Interaction of Alcohols and Ketones with Hydrogen on Heterogeneous Catalysts	Army Ordnance Research Durham, N.C.
Ohio State University Research Foundation, Columbus, Ohio	Stabilized Carbanions	Army Ordnance Research Durham, N.C.
Pennsylvania State University University Park, Penna.	Reactivity of Methylenes (Bivalent Carbon Species)	Army Ordnance Research Durham, N.C.
Purdue University Lafayette, Indiana	Michael Type Addition with Dinitro Paraffins	Army Ordnance Research Durham, N.C.
Purdue University Lafayette, Indiana	Aliphatic and Alicyclic Nitro Compounds	Army Ordnance Research Durham, N.C.
Purdue University Lafayette, Indiana	Chemistry of Homollylic Systems	Army Ordnance Research Durham, N.C.
University of Rochester Rochester, N. Y.	Aromatic Character in Polycyclic Molecules	Army Ordnance Research Durham, N.C.
University of Rochester Rochester, N. Y.	Migration Aptitudes in Molecular Rearrangements	Army Ordnance Research Durham, N.C.
Roosevelt University Chicago, Illinois	The Chemistry of Proximate Azido and Thio Groups	Army Ordnance Research Durham, N.C.
University of South Carolina Columbia, South Carolina	Benzion Condensations of Pivaladehyde and Related Aldehydes	Army Ordnance Research Durham, N.C.
University of Southern Calif. Los Angeles, Calif.	Mechanism of Isomerization of Diene Adducts	Army Ordnance Research Durham, N.C.
University of Southern Calif. Los Angeles, Calif.	Organosulfur Free Radicals and Organosulfur Ions	Army Ordnance Research Durham, N.C.
Research Foundation of State Univ. of New York Albany, New York	Reactivities of Trifluoromethyl Radicals & Tribromomethyl Radicals	Army Ordnance Research Durham, N.C.
Tulane University New Orleans, Louisiana	I. Acid-Catalyzed Reactions of Azides II. Fusion of Five-Membered Rings	Army Ordnance Research Durham, N.C.
Tulane University New Orleans, Louisiana	Long-Chained Compounds from Substituted Thiophenes	Army Ordnance Research Durham, N.C.
Vanderbilt University Nashville, Tenn.	Investigation of Disulfides, Sulfones and other Organic Sulfur Compounds	Army Ordnance Research Durham, N.C.
Washington University St. Louis, Mo.	The Chemistry of Diazomethane and Related Compounds	Army Ordnance Research Durham, N.C.
University of Washington Seattle, Washington	Solvent and Substituent Effects	Army Ordnance Research Durham, N.C.
University of Washington Seattle, Washington	Highly Strained Small Ring Compounds	Army Ordnance Research Durham, N.C.

CONTRACTOR	TASK TITLE	ARMY AGENCY
Wayne State University Detroit, Michigan	The Hammett Equation	Army Ordnance Research Durham, N.C.
Wayne State University Detroit, Michigan	The Stereochemistry of Additions to Olefins	Army Ordnance Research Durham, N.C.
Waye State University Detroit, Michigan	Unsaturated Azoxy Compounds	
University of Wisconsin Madison, Wisconsin	Solvolytic, Displacement, and Rearrangement Reactions in Allylic Systems	Army Ordnance Research Durham, N.C.
Pitman-Dunn Laboratories Frankford Arsenal, Philadelphia	Phosphoro-Ferrocene Polymers	Army Ordnance Research Frankford Arsenal-Philade
U. S. Army Res. & Eng. Command, Natick, Mass.	Exploratory Reseach in New Areas	Amy QM R&E Natick, Mass.
University of Connecticut Storrs, Conn.	Energy Absorption, Storage and Transfer	Amy QM R&E Natick, Mass.
Mass. Institute of Technology Cambridge, Mass.	Energy Absorption, Storage and Transfer	Army QM Research
Technische Hochschule Wien Wien XVIII/110, Austria	Study of Aerosols	Army R&D APO, 757, New York, N.Y.
University of London Royal Holloway College Surrey, England	Adsorption of Fluorocarbons by Porous Solids	Army R&D APO, 757, New York, N.Y.
Organization for Indus. Res. TNO, The Hague, Netherlands	High Temperature Fuel Cell	Army R&D APO, 757, New York, N.Y.
Instituto de Optica "Daza de Valdes", Serrano 121, Madrid	Correlations of Infrared Spectra and Chemical Reactivity	Army R&D APO, 757, New York, N.Y.
Instituto de Quimica Fisica Madrid, Spain	Thermochemical Investig. on Methyl-substituted Benzoic Acids	Army R&D APO, 757, New York, N.Y.
Trinity College-University of Dublin, Ireland	Investig. of the Structures and Properties of Metal-Organic Chelate Complexes	Army R&D APO, 757, New York, N.Y.
University of Edinburgh Edinburgh, Scotland	Study of the Mechanism of the Oxidation of Hydrocarbons	Army R&D APO, 757, New York, N.Y.
University College Dublin, Ireland	Absorption Spectra of Inorganic Solids	Army R&D APO, 757, New York, N.Y.
Universite Libre de Bruxelles Faculte de Sciences Brussels, Belgium	The Mechanism of the Photochlorination of Simple Chlorin. Hydrocarbons	Army R&D APO, 757, New York, N.Y.
University of London London, England	Optical Rotatory Dispersion of Organic Compounds	Army R&D APO, 757, New York, N.Y.
Institut f. Physikalische Chemie der Universitaet Graz, Austria	X-Ray Study of Fibers and Other Polymers	Army R&D APO, 757, New York, N.Y.
Universita di Bologna Bologna, Italy	Meetings of Molecular Spectroscopy	Army R&D APO, 757, New York, N.Y.
Institute de Quimica Fisica Serrano 119, Madrid, Spain	Kinetics & Mechanism of the Decomposition of Acetals	Army R&D APO, 757, New York, N.Y.
Centre de la Mecanique Ondulatoiree Appliquee Paris 15e, France	Photoactivated Prod. of Free Radicals from Diatomic Molecules after Absorption on Metallic Surfaces	Army R&D APO, 757, New York, N.Y.
University of Sheffield Sheffield, England	The Recombination of Atoms and Free Radicals	Army R&D APO, 757, New York, N.Y.

CONTRACTOR	TASK TITLE	ARMY AGENCY
Instituto di Chimica Fisica Dell' Universita di Pavia Pavia, Italy	Dipole Moment Studies of Diephenyl Ether, Diephenyl Sulfide and Their Derivatives	Army R&D APO, 757, New York, N.Y.
Central Inst. for Indus. Res. Blindern, Oslo, Norway	The Structure of Linear Polymers	Army R&D APO, 757, New York, N.Y.
Institut f. Physikalische Chemie Technische Hochschule Wien, Austria	Kinetics and Mechanics of the Diazotization Reaction	Army R&D APO, 757, New York, N.Y.
Institut f. Physikalische Chemie Universitaet Manz Manz, Germany	Heat and Entropy of Dilution of Serum Albumin Solutions	Army R&D APO, 757, New York, N.Y.
Instituto de Chimica Fisica Universita di Padova Padrova, Italy	A Study of the Molecular Structure of Formaldehyde & Related Compounds by Spectroscopic Techniques	Army R&D APO, 757, New York, N.Y.
Universite de Louvain Louvain, Belgium	Reaction Kinetics in Flame Inhibition	Army R&D APO, 757, New York, N.Y
Fritz Haber Institut der Max Planck Gesellschaft Berlin-Dahlem, Germany	Thermodynamics of Short Chain Macromolecule	Army R&D APO, 757, New York, N.Y.
Sonatone Corporation Elmsford, N. Y.	Study of Sealed Ni-Cd Cells	Army Signal USASRDL Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Magnesium Dry Cell	Army Signal Fort Monmouth, N.J.
Mallory Battery Co. Cleveland, Ohio	Improvement in the Storeability of Dry Batteries	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Investg. Into Reaction Mechanism of Nickel Oxide-Cadmium Cell System	Army Signal Fort Monmouth, N.J.
University of Missouri Columbia, Missouri	Electrochemical Systems for Use in Low Temperature Batteries	Army Signal Fort Monmouth, N.J.
Foster D. Snell, Inc. New York 11, N. Y.	Handbook on the Theory of Electrochemical Cell Reactions	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Study of Electrolytes Other Than KOH in Ni-Cd Batteries	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Formulation of a Practical Cd-AgO Cell Employing a Sealed Construction	Army Signal Fort Monmouth, N.J.
Eastman Kodak Company Rochester, N. Y.	Basic Research Investigs. for Ammonia Vapor Activated Batteries	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	High Rate Organic Depolarizer Systems	Army Signal Fort Monmouth, N.J.
Radiation Research Corp. New York, N. Y.	Vacuum Tririum Nuclear Battery	Army Signal Fort Monmouth, N.J.
Mound Laboratory Miamisburg, Ohio	Nuclear Battery - Thermocouple Type	Army Signal Fort Monmouth, N.J.
Westinghouse Electric Corp. Baltimore, Md.	Sola Cell Photoemission Type	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Hydrogen Oxygen Fuel Cell	Army Signal Fort Monmouth, N.J.

CONTRACTOR	TASK TITLE	ARMY AGENCY
USASRDL Fort Monmouth, N. J.	Ionic Membrane Fuel Cell	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Organic Fuel Cell Systems	Army Signal Fort Monmouth. N.J.
USASRDL Fort Monmouth, N. J.	Regenerative Fuel Cell Systems	Army Signal Fort Monmouth, N.J.
MSA Research Corporation Callery, Penna.	Regenerative Continuous Feed Galvanic Systems	Army Signal Fort Monmouth, N.J.
Pratt Whitney Aircraft E. Hartford, Conn.	500W Regenerative Hydrogen-Oxygen Fuel Cell System	Army Signal Fort Monmouth, N.J
Lockheed Aircraft Co. Sunnyvale, Calif.	Solar Regenerative Chemical Systems	Army Signal Fort Monmouth, N.J.
Linfield Research Institute McMinnville, Oregon	Res. on Electrolytic Micromachining Techniques for Field Emission Electron Devices	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Techniques for Preparation and Processing Ferroelectrics - Metal Ovides from Sol	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Techniques for Preparation & Processing of Ferrites from Solution	Army Signal Fort Monmouth, N.J.
USASRDL Fort Monmouth, N. J.	Synthesis & Fundamental Properties of Piezoelectric Crystals	Army Signal Fort Monmouth, N.J.
Clevite Research Center Cleveland, Ohio	Method for Improving Quality of Synthetic Quartz	Army Signal Fort Monmouth, N.J.
Baylor University Waco, Texas	Action of Organic Brightening Agents in Electroplating Processes	Army Ordnance Research Durham, N.C.
Polytechnic Inst. of Brooklyn Brooklyn, New York	Metal Chelation & Acid-Base Catalysis in Polyelectroplyte Solution	Army Ordnance Research Durham, N.C.
University of California Berkeley, Calif.	Reactions of Free Radicals Produced in Photochemical Processes	Army Ordnance Research Durham, N.C.
University of California Berkeley, Calif.	Ketyl Pinacolate Equilibrium	Army Ordnance Research Durham, N.C.
University of California Berkeley, Calif.	Photochemically Produced Free Radicals in Solution	Army Ordnance Research Durham, N.C.
California Inst. of Technology Pasadena, Calif.	Fundamental Processes Occurring at Electrodes	Army Ordnance Research Durham, N.C.
California Instit. of Technology Pasadena, Calif.	Homogeneous & Heterogeneous Chemical Reactions in Flow Systems	Army Ordnance Research Durham, N.C.
The Catholic Univ. of America Washington, D. C.	Production of New Species by Sudden Cooling	Army Ordnance Research Durham, N.C.
Cornell University Ithaca, N. Y.	Structure Analysis of Complex Compounds	Army Ordnance Research Durham, N.C.
Duke University Durham, N. C.	Discharge Mechanisms of Manganese Dioxide and Other Oxide Electrodes	Army Ordnance Research Durham, N.C.
Florida State University Tallahassee, Fla.	Nuclear Models II. Nuclear Levels Determined by Inelastic Scattering	Army Ordnance Research Durham, N.C.

CONTRACTOR	TASK TITLE	ARMY AGENCY
University of Illinois Urbana, Ill.	Experimental Research in Electrodeposition	Army Ordnance Research Durham, N.C.
University of Illinois Urbana, Ill.	Exploration and Application of Turbulence Theories	Army Ordnance Research Durham, N.C.
State University of Iowa Iowa City, Iowa	Infrared Intensity Studies of Condensed Phases	Army Ordnance Research Durham, N.C.
John Hopkins University Baltimore, Md.	Excited States of Some Simple Polyatomic Molecules	Army Ordnance Research Durham, N.C.
University of Kansas Lawrence, Kans.	Reduction of Organic Compounds by Lower Valent Species of Active Metals	Army Ordnance Research Durham, N.C.
University of Maryland College Park, Md.	Bond Dissociation Energies of Diatomic & Polyatomic Molecules	Army Ordnance Research Durham, N.C.
Massachusetts Inst. of Technology, Cambridge, Mass.	Gas Reactions at High Temperatures	Army Ordnance Research Durham, N.C.
Massachusetts Inst. of Technology, Cambridge, Mass.	Physical Chemistry of High Polymer Solution	Army Ordnance Research Durham, N.C.
University of Minnesota Minneapolis, Minn.	Study of the Intensities of Infrared Absorption Bands	Army Ordnance Research Durham, N.C.
University of Minnesota Minneapolis, Minn.	Shock Tube Studies of Chemical Kinetics	Army Ordnance Research Durham, N.C.
University of Minnesota Minneapolis, Minn.	Flash Photolysis of Labile Polyatomic Molecules	Army Ordnance Research Durham, N.C.
National Academy of Sciences Washington, D. C.	Compilation and Systemization of Information on Chemical Kinetics	Army Ordnance Research Durham, N.C.
National Bureau of Standards Washington, D. C.	Trapped Radicals at Low Temperatures	Army Ordnance Research Durham, N.C.
New York University New York, N. Y.	Ion Exchange in Corrosive Solutions and at Polarized Electrodes	Army Ordnance Research Durham, N.C.
University of North Carolina Chapel Hill, N. C.	Critical Phenomena & Related Topics	Army Ordnance Research Durham, N.C.
North Carolina State College Raleigh, N. C.	Properties of Non-Newtonian Fluids	Army Ordnance Research Durham, N.C.
Northwestern University Evanston, Ill.	Semi-Empirical Potential Energy Functions of Molecules	Army Ordnance Research Durham, N.C.
Northwestern University Evanston, Ill.	The Mechanism of Chemisorption	Army Ordnance Research Durham, N.C.
Pennsylvania State University University Park, Penna.	Thermodynamics of Simple Gases Adsorbed on Solids	Army Ordnance Research Durham, N.C.
Princeton University Princeton, N. J.	Dialectric Relaxtion and Structure	Army Ordnance Research Durham, N.C.
Saint Joseph's College Philadelphia, Penna.	Absorption and Reaction of Labelled Gases on Nickel Single Crystals	Army Ordnance Research Durham, N.C.
Univ. of So. California Los Angeles, Calif.	Absolute Rates of Some Free Radical Reactions	Army Ordnance Research Durham, N.C.
Univ. of So. California Los Angeles, Calif.	Interatomic Distances in Molecules and Crystals	Army Ordnance Research Durham, N.C.
Univ. of So. California Los Angeles, Calif.	Vibrational Spectra of Crystals at Low Temperatures	Army Ordnance Research Durham, N.C.
Univ. of So. Calilornia Los Angeles, Calif.	Particle Interactions in Colloidal Systems in Non-Polar Media	Army Ordnance Research Durham, N.C.
Univ. of South Carolina Columbia, S. C.	Temperature Dependence of Properties of Electrolytes in Non-Apueous Solvents	Army Ordnance Research Durham, N.C.
University of Tennessee Knoxville, Tenn.	Influence of the Kramer Effect on Metal Adsorption	Army Crdnance Research Durham, N.C.
University of Texas Austin, Texas	Diffusion of Gases in Aqueous Solution	Army Ordnance Research Durham, N.C.
University of Texas Austin, Texas	Pressure - Volume - Temperature Relationships of Gaseous Compounds	Army Ordnance Research Durham, N.C.
University of Texas Austin, Texas	Study of Electronic Structure of Molecules	Army Ordnance Research Durham, N.C.
Texas A.&M. Research Found. College Station, Texas	Structures and Reactivities of Boroxazolidines	Army Ordnance Research Durham, N.C.
University of Utah Salt Lake City, Utah	Investigation of Fundamental Chemical Reactions	Army Ordnance Research Durham, N.C.
Wake Forest College Winston-Salem, N. C.	Molecular Size and Arrangement in Complex Formation	Army Ordnance Research Durham, N.C.
University of Washington Seattle, Wash.	Transport Properties of Liquids and Gases at High Temperatures	Army Ordnance Research Durham, N.C.
University of Washington Seattle, Wash.	Heterogeneous Equilibria	Army Ordnance Research Durham, N.C.
University of Washington Seattle, Wash.	Adsorption in Heterogeneous Catalytic Reactions	Army Ordnance Research Durham, N.C.
Wayne State University Detroit, Mich.	Determination of Statistical Shape of Partially Flexible Macromolecules by Dityndallism	Army Ordnance Research Durham, N.C.
University of Wisconsin Madison, Wis.	Volumetric & Thermodynamic Properties of Gaseous & Liquid Mixtures	Redstone Ars.-Ordnance Alabama
Pitman-Dunn Laboratories Frankford Arsenal	Synthesis of Contractile Polyelectrolytes	Frankford Ars.-Ordnance Philadelphia, Penna.
Watertown Arsenal Lab. Watertown, N. Y.	Study of Solubility in Solids	Watertown Ars.-Ordnance Watertown, N.Y.
ARGMA Redstone Arsenal, Ala.	Spectroscopic Study of Butane	Redstone Ars.-Ordnance Alabama
Watertown Arsenal Lab. Watertown, N. Y.	Characterization of Transition Metal Surfaces	Watertown Ars.-Ordnance Watertown, N.Y.
Pitman-Dunn Laboratories Frankford Arsenal Philadelphia, Penna.	Radiolysis of Organic Compounds	Frankford Ars.-Ordnance Philadelphia, Penna.
National Bureau of Standards Washington, D. C.	High Polymers and Conjugated Organic Compounds	USArmy QM Res. & Eng. Command-Natick, Mass.
Princeton University Princeton, N. J.	High Polymers and Conjugated Organic Compounds	USArmy QM Research
Massachusetts Inst. of Technology, Cambridge, Mass.	High Polymers and Conjugated Organic Compounds	USArmy QM Research
State University of New York Syracuse, N. Y.	High Polymers and Conjugated Organic Compounds	USArmy QM Research

SOVIETS TRAINING WITH CHEMICAL WEAPONS

Involves All Echelons

CBR training in the USSR includes not only the military application of chemical weapons but civilian defense against these weapons as well.

Civilian defense training is given through the Voluntary Society for Cooperation with the Army, Navy and Air Force, and a civilian organization (DOSAAF) of pre-military age and adult civilians. BW and Radiological training are lumped with CW defense, with emphasis on CW weapons. DOSAAF has an estimated 30 million members and places great emphasis on passive defense measures against air chemical attack.

Civilian training is the continuation of a Soviet policy on chemical weapons which has been carried on for 30 some years past. An extremely efficient civilian protective mask has been developed by the Soviets and it is offered for sale in local stores.

Military training in CBR begins with defensive CW training included in military courses given to students at all levels. This training is also given to members of school age paramilitary organizations. After induction into the Army this training continues.

Military Personnel

Enlisted personnel are taught use of the mask, anti-spray cape, and identification of agents by odor through the use of a sniff-kit. Protective mask training includes wearing the mask during duty hours and tactical exercises.

Soviet NCO's are trained in special schools with courses lasting from nine months to two years. Emphasis is on toxic agent reconnaissance, decontamination and preparation for CBR instruction. Specialist schools for other Arms and Services also give 90 to 100 hours for CBR training over a 9-month period.

Chemical Warfare officers in the Soviet Army are trained in CW Officer Candidate Schools, or commissioned from the graduates of institutes or universities where the students have received scientific and military training. Students in OCS are trained in offensive and defensive CBR, as well as in tactics and in basic and advanced chemical laboratory work.

Officers are given advanced training at the Vorochilov Military Academy of Chemical Warfare Defense in Moscow. The Frunze Military Academy (General Staff Academy), attended by battalion and regimental commanders for a three-year course, has CBR instructors and includes CBR tactics in its curriculum.

Soviet Troop Units

Troop units are given gas chamber exercises at least annually, and are drilled in replacement of defective gas mask components. Units in training observe special days when masks are worn continuously for increased periods of time, reported to be as much as six hours.

Most Soviet troops are given explanatory instruction in radiological defense. They are told about dosimeters, survey meters, and contamination meters. In some organizations, these instruments are demonstrated. Specialists who are members of radiological reconnaissance teams are issued the instruments and trained in their use. Troops are told individual dosimeters will be issued if and when atomic war takes place.

The Soviet equivalent of our Chemical Corps is a large, well-trained organization. The USSR must be credited with an across-the-board capability in CW agents and weapons, including a persistent type nerve gas.

Toward the end of World War II, the Soviet troops captured German G-agent plants, complete with staff personnel. They have been producing a G-agent which they call Tabun, probably the original German product. Little can be said about their development of persistent type nerve gases, but they have produced a closely related insecticide.

The Soviets have shown a great interest in hydrogen cyanide, a gas used by California and other states in executions. They have indicated that it can be thickened and sprayed effectively from a plane at about 50 feet from the ground. The U.S. Army Chemical Corps is inclined to regard this agent as obsolete for military purposes.

Soviet Chemical Policy

Stated USSR policy has been to provide a chemical warfare potential for every suitable weapon on the ground. In World War II, they had shells for both mortars and artillery charged with chemical agents. The Soviet Army must be viewed with chemical weapons capable of attacking all tactical targets. Soviet aircraft and rockets provide a capability for attack on far strategic targets. The extensive civil defense training in the USSR indicates that long-range CW attacks are considered practical in their plans.

Soviet cluster bombs employ the principle of dispersion of frangible ampoules containing CW or BW agents. Air weapons would also include rockets for point targets, clusters for area targets, and spray tanks for direct attack on personnel with liquid agents.

In terms of quantity in stockpile and production at this time, the USSR probably has more mustard than any other agent. The fact that mustard is solid at low temperatures, which prevail over Russia during a large part of the year, has led them to develop a number of mixtures of mustard with other toxic agents, or chemicals to hold a liquid form. Persistent gases, too, last much longer in the field when the climate is cold.

Considerable emphasis has also been placed on so-called toxic smokes, vaporizing toxic agents or tear gas in smoke. Harassing effects or vomiting agents such as Adamsite are available, and it is possible that those agents could be employed with the idea that troops would be prevented from wearing masks under incapacitating conditions.

The protective mask of the Soviet Army, the Shlem Maska-1, a helmet mask, is characterized by virtually complete coverage of the head with soft rubber. This mask is considered one of the safest available. CW protective clothing is also adequate. Detection equipment and identification of agents includes the use of indicator papers, or silicon-gel packed tubes with reagents to color reactions with CW agents. Larger equipments range in capability from detection and recognition of specific agents to complete coverage of CW, BW and sanitary laboratory work by larger units.

Individual decontamination kits are in use which neutralize mustard, Lewisite, or sulphur containing nerve agents. There is also equipment for personnel decontamination and steaming equipment for military clothing.

NOTE: *Information in this article was gathered from several sources. It is printed so the readers may have a better understanding of the Soviet position with CBR weapons—The Editor.*

ITALIAN GENERAL VISITS U. S. ARMY CHEMICAL CORPS

Becomes Honorary Member

Brigadier General Grissanto Mulas, Chief, Office of Chemical, Biological and Radiological Warfare, Italian Defense Department, became an honorary member of the U.S. Army Chemical Corps during his 18-day visit and tour of Army installations in the United States.

Major General Marshall Stubbs, Chief Chemical Officer of the U.S. Army, presented General Mulas with a certificate of honorary membership in the Chemical Corps when his visit and tour began.

Lieutenant Colonel Francesco Amadei and Captain Luigino Mammarella of the Italian Army accompanied General Mulas. Lt. Colonel Amadei, who received a Doctorate in Chemistry at the University of Rome, has been working with military chemistry problems for the past twenty years. He has been Chief of the Technical Office of CBR Defense for the past three years. Captain Mammarella has received Doctorates in Pharmacy and Biology and is the Commander of a CBR Research Company.

Lieutenant Colonel Louis Stefani, U.S. Army Chemical Corps, was the escort officer for the visitors.

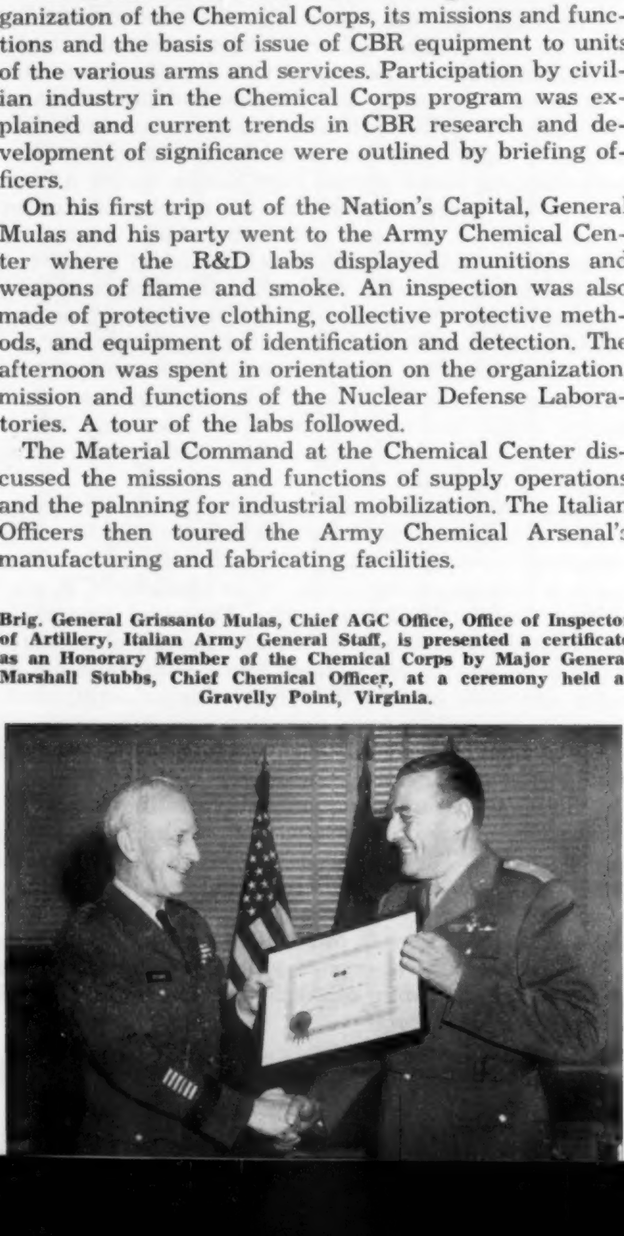
General Mulas is an Artillery officer who has been Commanding Officer of the 27th Artillery Regiment; Commandant, Unique Combined Services Defense CBR School; and Commanding General of the "Granatieri di Sardegna" Artillery Division.

The visitors were briefed in Washington on the organization of the Chemical Corps, its missions and functions and the basis of issue of CBR equipment to units of the various arms and services. Participation by civilian industry in the Chemical Corps program was explained and current trends in CBR research and development of significance were outlined by briefing officers.

On his first trip out of the Nation's Capital, General Mulas and his party went to the Army Chemical Center where the R&D labs displayed munitions and weapons of flame and smoke. An inspection was also made of protective clothing, collective protective methods, and equipment of identification and detection. The afternoon was spent in orientation on the organization, mission and functions of the Nuclear Defense Laboratories. A tour of the labs followed.

The Material Command at the Chemical Center discussed the missions and functions of supply operations and the palnning for industrial mobilization. The Italian Officers then toured the Army Chemical Arsenal's manufacturing and fabricating facilities.

Brig. General Grissanto Mulas, Chief AGC Office, Office of Inspector of Artillery, Italian Army General Staff, is presented a certificate as an Honorary Member of the Chemical Corps by Major General Marshall Stubbs, Chief Chemical Officer, at a ceremony held at Gravelly Point, Virginia.



At Fort Detrick, the visitors were briefed on biological research and munitions development.

The Chemical Corps Training Command at Fort McClellan included briefings on military arts, logistics, training, and technical problems. Curriculum development was also part of discussions. A helicopter was to travel to the Pelham Range to observe a radiological survey during the tour of the Chemical Corps School.

General Mulas toured the Dugway Proving Ground by air, but visited the test facilities on the ground. At the Rocky Mountain Arsenal, the visitors saw the manufacturing and storage facilities and were briefed on industrial operations. Back in Washington, General Mulas spent the final day of his visit in conferences with Lieutenant General Arthur G. Trudeau, Major General G. O. N. Loden, and Major General Marshall Stubbs.

PEOPLE

Dr. Ernest I. Becker, professor of organic chemistry at the Polytechnic Institute of Brooklyn, is the recipient of a grant of $43,000 from the National Science Foundation in support of his basic research in the field of organo-magnesium compounds.

Dr. Mortimer Rothenberg has returned to duty after attending the Tripartite Conference in Salisbury, England, and a vacation through Europe to Tel Aviv. Dr. Rothenberg is Deputy Commander for Scientific Activities at Dugway Proving Ground.

Mr. Harry A. Wansker was invited to the International Conference on the Political Warfare of the Soviets, a discussion of Soviet economic and propaganda techniques, which was held in Paris in December.

Col. Samuel P. Pickett, President of the Southern California Chapter, is recovering at his home in Whittier, from burns suffered in a serious casing head explosion. His hair and eyebrows were burned off and his hands and arms suffered when he crawled away on the ground which had been turned into a frying pan by the explosion.

Lt. Col. Douglas Lindsey, MC, who is director of Medical Research at the Army Chemical Center Research and Development Labs, has been named consultant to the Surgeon General of the Army, in the field of chemical warfare.

Frank W. Berryman, Jr., who served as a 2nd Lieut., and instructed on portable gas plants at the Engineer Officer School, Fort Belvoir, Va., is now Sales Manager for the Eagle Chemical Company of Mobile, Alabama. He is a graduate chemical engineer from M. I. T.

Major General Richard A. Grussendorf, USAF (Ret.), former Assistant Chief of Staff of the U.S. Air Force, has joined Hazeltine Corporation.

Earle M. Jorgenson has been elected to the board of directors of American Potash & Chemical Corporation. He is a director of Citizens National Bank, Northrop Corporation, Rheem Manufacturing Company, Transamerica Corporation, and a member of the board of trustees of California Institute of Technology and Occidental College.

George B. Mosley is now Vice President in Charge of Marketing for Celanese Corporation.

John J. Healy, an executive of the Monsanto Chemical Company, has been named President of the American Institute of Chemical Engineers for the coming year. **Carl F. Brutton,** Executive Vice President, Chemical Division, Food Machinery and Chemical Corp. was elected to the Board of Directors for three years.

PINE BLUFF TO MAKE CS GRENADES IN '61

Pine Bluff Arsenal is scheduled to produce CS munitions, of the M7 series burning-type grenade, by next spring. The grenade will be made available through the Army supply system.

CS is an Army chemical symbol for an agent that causes burning and watering of the eyes, irritation of the respiratory passages, and temporarily renders people unable to perform with effective action. After a short period in fresh air recovery is complete.

Army Engineers are converting buildings at Pine Bluff for the new machinery.

FIELD TEST FOR FALLOUT

This winter the Army Chemical Corps will conduct tests on decontamination of fallout under winter conditions, using the facilities of Camp McCoy, Wisconsin. Test direction will be furnished by the Army Chemical Corps Nuclear Defense Laboratory at Army Chemical Center, Md.

Tests will be conducted using a fallout simulant composed of ordinary smooth sand which has been tagged with a radioactive isotope tracer having a very short life.

BOOKS

One of the most important works on chemical warfare to be put between covers in recent times is *Non-military Defense*, a study of chemical and biological defenses in perspective. It contains a series of 12 papers by different authors who prepared these studies and presented them at the American Chemical Society meeting this year.

The well-known men who have presented these papers: are C. E. Ronneberg, Denison University; G. B. Bleicken, John Hancock Mutual Life Insurance Company; W. H. Summerson, USA CmlC Research and Development Command; L. D. Fothergill, Fort Detrick, Md.; Marshall Stubbs, Major General USA; H. C. Lueth, American Medical Association; B. C. Taylor, Office of the President of the United States; G. D. Rich, Office of Civil and Defense Mobilization; A. W. Donaldson, Department of Health, Education and Welfare; C. S. Sheldon II, Congress of the United States; Paul Weiss, Rockefeller Foundation; and C. F. Rassweiler, Johns-Manville Corporation.

The book doesn't pull punches. It lays the problem on the line. Under the title of Apathy and Defense, Mr. Bleicken writes:

"I am completely convinced that today any real distinction between military and nonmilitary defense is meaningless. The effectiveness of our military forces may well represent unacceptable risks to an aggressor, but the real possibility of multimillions of American casualties hampers and blunts the use of our military forces and of course automatically our foreign policy. . . .

"What has not been appreciated and has apparently gone by almost unnoticed is the change in the importance of nonmilitary defense to military and political decisions. . . . Today, as we enter the missile era with its vastly more devastating weapons, nonmilitary defense may in fact under some circumstances have become controlling. Its inadequancy and the resulting time lag in national planning could assume awesome significance if we were called upon to face up to a great military crisis in the near future and we have not taken adequate measures to protect the people. . . .

"I believe it to be the absolute duty of knowledgeable people in government, in science, in the professions, in business, in labor, and in the universities to take part in the framing of the issues of their time and to work toward their determination. If the issues are to be so framed that a democracy can act upon them, it is our obligation as public and private citizens to become informed, to participate, to propose, and to act. . . ."

These excerpts show the scope and range of this important paper-back volume. It is listed as No. 26 in the *Advances in Chemistry Series*. It can be ordered from the American Chemical Society, 1155 16th Street, NW, Washington 6, D.C. Price $2.00

Isotope Effects On Reaction Rates by Lars Melander, is a brief presentation of the main principles of kinetic isotope effects without an attempt to cover the entire field. Instead, the author discusses rather thoroughly a few illuminating procedures and compares different theoretical methods of isotope effects as a scientific tool. Mr. Melander, a native of Sweden, is a graduate of the University of Stockholm and is head of the Nobel Institute of Chemistry. Mrs. Melander prepared the drawings and the numerical computations for the diagrams in this book. It is a monograph of 167 pages published by the Ronald Press Company.

Polaris: James Baar and William E. Howard, editors of the magazine *Missiles and Rockets,* have written their story of this top-flight weapon in our arsenal. It is fascinating reading because the reader finds himself sitting-in at the conference table when the problems and magnitude of a successful creation in the modern weapons field are discussed. The book is non-technical and easy to read. Development of *Polaris* has enough firsts to hold the reader's interest, and the Monday morning quarterback can work-out at a faster pace. Those interested in chemistry will be particularly pleased to find the success of *Polaris* was dependent upon the chemical creation of a solid fuel. The book, too, is a tribute to the Navy way of doing things. The authors are inclined to take pot-shots at political personages as they begin their story, but it neither helps nor hurts. It's like the Hollywood director of the western movie who wants cowboys riding through the canyon when Indians suddenly materialize atop the canyon walls ahead. Something is going to happen.

The book is 245 pages and published by Harcourt, Brace and Company.

The Amateur Scientist is a how-to-do-it for building at atom-smasher, a cloud chamber, research rockets, an X-ray camera, an electronic weather forecaster, and how to grow algea on the window shelf; how to study humming birds, earthquakes, or build an electronic mouse that learns from experience. Many of these experiments have been made by high school students. The author, C. L. Stong, publishes a monthly column which covers the activities of the amateur scientist in *Scientific American,* and some of the material in this book has appeared in that publication. This book provides a challenge in astronomy, archaeology, biology, natural sciences, nuclear physics, mathematical machines, aerodynamics, optics, heat, and electronics. The introduction is written by Dr. Vannevar Bush. Simon and Shuster are the publishers and the book is 558 pages.

CHEMICAL WARFARE TRAINING

A challenge to the initiative of the small-unit commander

By Colonel John M. Palmer
Commanding Officer
U.S. Army Chemical Corps Training Command
Fort McClellan, Alabama

The quickest way to reduce the effectiveness of a military training program is to train without purpose or sense of urgency. Unfortunately, for 40 years an aimless approach has largely characterized unit chemical warfare training in the U.S. Army.

Admittedly, it is difficult to interest troops in a weapon which has been frequently shrouded in secrecy and has not been extensively employed by any nation since World War I. Even when individual commanders have attempted to increase or accelerate chemical warfare training, the approach more often than not was largely additional routine training. Much of the Army still appears to visualize chemical warfare, and related biological warfare training, as an annoying distraction from normal combat training.

The Case For More Dynamic Chemical Warfare Training

Is there a case for more dynamic and realistic chemical warfare training, or can we continue with minimum and routine training?

The great advances made in the quality of chemical agents and the means of employing them by both the United States and the Soviet Union in the past few years dictate the former approach to training.

If we develop a useful weapon but not the ability to use it, we waste our resources. If the enemy develops a weapon for which we do not have the equal, we give him the initiative; if he develops one against which we have no defense, we give him the battle victory. But, if we learn neither to protect ourseles against his modern weapons nor to employ our own effectively, we may lose the way of life of our people.

Few present-day soldiers realize that of the more than 200,000 casualties suffered by the American Expeditionary Forces in World War I, nearly one-third were caused by toxic agents, and in all probability the Germans and our allies experienced the same relatively high proportion of gas to high explosive casualties. Throughout this war, chemical warfare was a major consideration in nearly every operation. Invariably units who were poorly trained in this phase of warfare suffered disproportionately heavy casualties. More on these factors later—but it must be pointed out that the total chemical warfare training time in the current Army Training Program hardly reflects the importance of a weapon which produced one-third of our casualties in World War I.

Moving up the ladder a few years, let's examine present-day Soviet interest in chemical weapons. Being practical fellows, the Soviets waste little time on frills. The Soviet Army's concentration on combat and combat support functions and the exclusion of many individual support activities (personal conveniences) is well known. Yet in this "practical" army are special units devoted to chemical warfare in each division and at each echelon down to and including battalion. The Soviets are reported to have large stockpiles of the nerve gas Tabun (GA) and other chemical agents ready for use. Civilian defense training programs, including chemical warfare protection, have been completed by over 30,000,000 Soviet citizens.

ABOUT THE AUTHOR

Colonel John M. Palmer entered the Army in 1927. After service with the 17th Infantry, he transferred to the Chemical Warfare Service. During World War II he was assigned to the Operations Division, War Department General Staff and later assumed the position of Chief, Training Division, Headquarters Communications Zone, France. After the war he served on the Staff and Faculty of both the Chemical Corps School and Army War College. On 23 July 1956, Colonel Palmer assumed command of the U.S. Army Chemical Corps Training Command. On 18 July 1960 Colonel Palmer was assigned command of Pine Bluff Arsenal at Pine Bluff, Arkansas.

Letting the Soviets speak for themselves; Admiral Gorshikov stated that "future war will be characterized by various means of mass destruction such as atomic, thermonuclear, chemical, and bacteriological weapons." Recently, Major General Yu V Drugov, of the Medical Service, Soviet Army, stressed that "special interest attaches itself to the so-called psychic poisons (psychochemicals) which are now used for simulation of mental disease."

Since World War II the United States has also carried forward an increasingly active program of research and development in chemical weapons systems. Olde

chemical agents have gone through considerable face lifting so that many of the identifying features, such as color and odor, have been altered or eliminated. For instance, the soldier who waits for the characteristic garlic odor of our World Wars I and II mustard before donning a protective mask will be a casualty in the next war.

The highly toxic nerve gases—such as Tabun, developed by the Germans in World War II—have been extensively investigated, and Sarin (GB) has been developed for military use. New agents causing temporary physical incapacitation and mental aberration are also receiving considerable attention from U.S. military scientists. Protective equipment is being rapidly developed to parallel developments in chemical-biological agents, and recently a new protective mask (the M17) incorporating many advanced features was made a standard item of Army issue.

The advances in chemical warfare have made it a potent and indispensable weapon, and, of course, our potential enemies have shown considerable capability in this area.

Case Studies In Chemical Weapons Employment

Both the Japanese and Italians employed chemical-biological weapons between the two World Wars, but only in a limited and sporadic fashion. Therefore, our studies of gas warfare must be largely gleaned from World War I. The three case studies that follow are not necessarily typical of all World War I gas warfare, but they do illustrate some of the potentials of chemical weapons and related training needs.

A Study of General Training in Relation to Surprise Chemical Attack: Throughout World War I both sides sought to gain surprise by employing new agents or old agents in new ways. The decisiveness of a gas attack frequently depended on the general status and flexibility of unit training. In studying the defense against the first gas attack at Ypres on 22 April 1915, we should consider the status of training and discipline. The attack was primarily directed against the French 87th Territorial Division and the 45th Algerian (Colonial) Division, but it was also made against the left flank of the Canadian contingent. While it is difficult to categorize these soldiers, it might be said that the territorial division was composed of second-level French troops with marginal training, and that the Algerian Colonials were not particularly sophisticated or educated.

After the German cloud of chlorine reached the 45th Division, this unit largely disintegrated. The Algerians were seen moving to the rear in large numbers with-

(Continued on page 36)

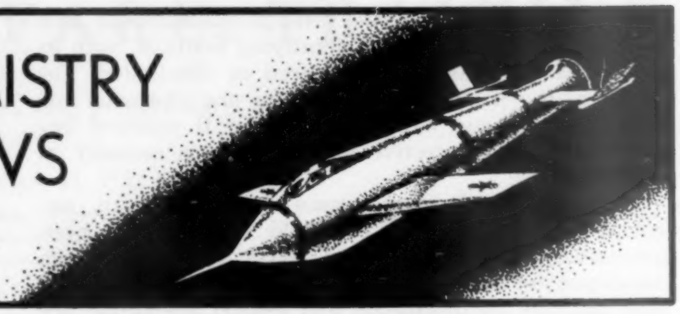
CLEANING UP—Students in the U. S. Army Chemical Corps School, dressed in protective clothing and masks, scrub their boots prior to going through the personnel decontamination station during a practical exercise in chemical warfare defense.

A CHEMICAL WEAPONS CHECK LIST FOR UNIT COMMANDERS

Review your chemical weapons training against the following check list. A "no" answer indicates that you are not taking full advantage of the capabilities of these weapons or that you may be developing a unit which is vulnerable to chemical weapons attack.

1. Am I, and is each of my men, fully proficient in the use of individual protective measures against CW attack?
2. Is my CW training program realistic? (Or is it generally a "drill" type activity?)
3. Have I used imagination when including CW in my training program?
4. Does my training program reflect the fact that over one-third the casualties of the American Expeditionary Forces in World War I were caused by gas?
5. Have I improvised new training techniques and aids in my program? (Or is the training pretty much by the numbers?)
6. When making plans for offensive operations, have I considered the advantages that toxic agents may have in the operation if authorized for use?
7. When making plans for tactical operations, have I considered the advantages that could accrue to the enemy if he used toxic agents?
8. Are my men psychologically prepared to encounter their first enemy attack by toxic chemicals? (Or would they panic?)

DEFENSE CHEMISTRY IN THE NEWS



WILLIAM T. READ, SR.

This Department consists of condensations of news releases and of articles in technical journals relating to developments in chemistry, chemical engineering, and kindred subjects, which are of definite or probable military interest. For the benefit of readers who may wish to refer to the source material upon which the paraphrased items are based, the source publications used for this review with appropriate reference numbers are listed after the last item of the text herein.

INORGANIC CHEMISTRY

Under the sponsorship of the Air Force, silicon carbide transistors are being developed that promise to become important competitors of hyperpure silicon. These transistors are reported as being capable of operating at temperatures above 650°F, whereas limits for silicon are 400°F and germanium 200°F. A silicon carbide transistor is described as acting like a diaphragm pump as it "squeezes" electrons along. It is unipolar, in contrast to bipolar silicon and germanium transistors, and uses no third voltage to accelerate electrons. The silicon carbide contains less than one impurity in 10,000,000 parts of carbide, compared with transistor silicon, whose impurities are measured in parts per billion. Purification is accomplished by vaporized aluminum at a high temperature. Initial use will probably be in aircraft and space vehicles. The extreme in miniaturization is realized when the dimentions of the transistor are given as 0.080 in. by 0.040 in., with a surface smaller than the head of a common pin. (1)

On a contract with the Atomic Energy Commission and the U.S. Air Force, a process has been worked out for making high-purity beryllium hydroxide as an ultimate product from which other compounds can be made. The method depends on the insolubility of beryllium basic acetate $[Be0.3\ Be(C_2H_3O_2)_2]$. Starting with technical grade beryllium hydroxide, acetic acid is charged into the reactor and brought to reflux and then, after slight reduction of temperature, the hydroxide is added in dry form and dissolved. Insoluble material is filtered off. After cooling the basic acetate crystallizes and is collected on an extra-coarse fritted glass filter, and is washed free of water-soluble impurities. The basic acetate is recrystallized. Residual muds are mainly iron-magnesium silicate. By hydrolyzing the basic acetate to the hydroxide and filtering its solution to reduce silica to less than 10 p.p.m. the basic acetate, however, may be extracted by chloroform to get rid of traces of metallic impurities. (2) (3)

Tetrafluorohydrazine, N_2F_4, is a chemical for which there is yet little industrial use, but whose potential uses are classified and are under investigation. If one or more of these pays off and is ultimately released for civilian industry, it may become a very important product. Several chemical manufacturers have been studying methods of manufacture, and the material is also of considerable research interest. The most recently released process involves the use of a fluidized bed of petroleum coke whose particle size ranges from 80 to 200 mesh, supported by graphite lumps of considerable larger size above copper wool. Only the coke bed is the heated zone. At the outset of the operation the bed is fluidized with an inert gas such as helium, after which the raw material, nitrogen trifluoride is introduced. The reaction is carried out at around 400°C. Unreacted trifluoride is removed and other by-products and fluoridized hydrocarbons separated as far as possible from the tetrafluorohydrazine. Hexafluoroethane has about the same volatility as the man product and is very hard to be separated by distillation. Fortunately the fluorinated hydrocarbon is inert and does not interfere with most uses of the fluorinated hydrazine. (4)

A recent review of the commercial use of fused salts, not only in the well-known electrochemical production of metallic aluminum, sodium, and magnesium, but in the production of less common metals, and the many and varied uses of fused salts in the atomic field, fluxing, and descaling metals, heat transfer, together with a survey of fundamental research in this comparatively unexplored field. Included in the metals now being prepared by reduction by active metals such as sodium, calcium, and magnesium, and by electrolysis with impure metal or such compounds as carbides, nitrides, and borides are titanium, zirconium, niobium, and tantalum. In the field of atomic power, molten fluorides are used instead of solid fuels, solvents, and coolant, and as a source of pure uranium by electrolysis. Uranium is separated from spent fuels by the fluoride volatility process. Thorium is transmuted into uranium-235, being dispersed as thorium bismuthide in molten bismuth. Fused salts are variously employed in fluxing and descaling metals, and as a flux and reagent in nitriding steels. A related process uses fused hydroxide as a solvent for sodium hydride, the latter being regenerated during the process by hydrogen. Fused salts as heat transfer agents are employed in pipes in catalyst bed crackers in the petroleum industry, in the control of the temperature of reactive gases and vapors passed through them, and in the possible recovery of oil from shale. In fuel cells they may permit the use of cheap fuels, gases, liquids, and solids, and, in spite of high operating temperatures, may prove useful because of the compact structure of cells in which they are contained. Fundamental research is being carried out in such fields as the ionic structure of used salts, their association or complexing, potentials between elements and their ions, and transports of used salt ions. (5)

METALS

Low grade ores of the jasper type are beneficiated to a concentration that makes them suitable as blast-furnace feed, but only when agglomerated, since the fines from the flotation would otherwise be

blown out of thetop of the furnace. Hard pellets of around 60% iron concentration and about 0.5 inch in diameter are produced by adding a small amount of water to the flottaion product, and employing a little bentonite clay as a binder. (Calcium lignosulfonate is also reported as a good binder for nonmagnetic, low-grade ores. Pellets are harder and the organic material lower the heat requirements for the finishing the pellets.) The mixture travels to balling drums which are tilted and rotate slowly. Undersized pellets are screened out and returned. The pellets then form a bed 7 to 8 inches thick on a travelling grate where they are first dried by hot gases, and, after passing a baffle, are brought up to 1800°F to 2000°F. They then go into a long rotary kiln where they are further heated to a maximum of 2450°F. If heated much hotter magnetite would be formed and this results ina plastic slag which would interfere with kiln operation. The pellets have in the whole process undergone grain growth with interganular bridging. They are then ready to function in a blast furnace as well as the high-grade ores that are ordinarily fed to it. (6)

Vanadium extraction is being employed in a plant due to begin operations in the spring of 1961, the raw material being a slag from a phosphorus furnace that contains about 5% of this metal. The slag is tapped from the furnace to be treated in equipment resembling a Bessemer converter. The concentrate with 12% to 14% vanadium is roasted with sodium chloride, leached with water, and purified by solvent extraction of the vanadium oxide. Precipitation and heating gives vanadium pentoxide. An output of 1.5 million pounds of vanadium is expected the first year of operation. (7)

From data furnished by various private companies to the Defense Metals Information Center, a memorandum has been issued regarding a cobalt-chromium-tungsten alloy which is employed in gas-turbine components requiring high strength properties between 1000°F and 2000°F. It has been used primarily as a first-stage turbine vane, supplanting an older alloy. It is also expected to be useful above 1800°F in applications requiring resistance to thermal shock, fatigue, and oxidation, but with lower strength requirements. It is available only in the form of castings. (8)

Metallic beads ranging from 20 to 150 microns in diameter have been developed, particularly as a fuel additive to increase the thrust of solid-fuel propellants by improving burning stability as well as lessening the handling sensitivity that is characteristic of highly reactive powders. The metal beads are said to form a mass that is free of voids, cavities, and inclusions. Nickel, copper, aluminum, tungsten, nichrome, stainless steel, and highly reactive alloys can be formed into these beads. (9)

Metallic beryllium is now being made with a purity of 99.5% by reduction of the fluoride by magnesium, the product having a potential usefulness in the field of aeronautics. The process starts with crushed beryl, beryllium-aluminum silicate. Its crystal structure is destroyed by melting in an arc furnace lined with carbon, and a frit is made by quenching the salt in water. Finely ground frit is converted by 93% sulfuric acid to beryllium sulfate with removal of silica as sludge. Clear supernatant liquid from the thickeners is treated with ammonium hydroxide to remove excess sulfuric acid as ammonium sulfate and to take out the last traces of silica. Sodium hydroxide converts the beryllium sulfate to sodium beryllate, which is hydrolyzed to beryllium hydroxide. (As noted in an earlier paragraph, the commercial product is converted to a very pure basic acetate for nuclear use.) In the fluoride process ammonium beryllium fluoride is crystallized and converted finally to beryllium fluoride by heating in an induction furnace to 1650°F. Ultimate reduction with magnesium to the metal takes place at 2370°F, which is solidified in graphite pots, crushed, leached, and vacuum cast to get rid of residual magnesium and slag. (10)

Researches carried on by an Air Force contractor have resulted in the development of brazing filler alloys which can be volatilized during the brazing of stainless steels to leave joints of high remelt temperature. With alloys containing nickel, chromium, germanium, iron, lithium, and phosphorus, the two main mechanisms were the dissolution of the base metal in the filler metal and diffusion of constituents of constituents of the filler metal in the base metal, and, secondly, the volatilization of the filler metal constituents. Nickel-indium and nickel-chromium-indium-germanium alloys proved most practical for high-temperature usage. (11)

ELECTROCHEMISTRY

Tough metals, including stainless and carbon steel, aluminum, and many other metals and alloys may be shaped chemically at low cost by shaped electrodes serving as cathodes, while rough forgings or metal stock act as an anode. The electrolyte of undisclosed composition, but which is specific for each type of metal, is pumped under pressure into the space between the electrodes and the metal to be "chemically machined," which erodes into the desired shape by relatively inexpensive direct durrent. (12)

An electrophoresis process of the "filter press" type which has been used successfully to reduce the gamma globulins of animal blood appears to have further biological and industrial chemical uses. Instead of the expensive ion exchangers used in desalting water, only filter sheets of paper or microporous polyvinyl chloride and membranes of a regenerated cellulosic product such as sausage casings are employed. The whole object is separation of colloids by charge and size rather than removal of electrolytes. A series of cells are made up of the filter and the membrane operating in parallel with platinum electrodes at each end of the equipment. Material migrating to the positive plate are mainly colloidal particles with negative charges while nonpolar molecules or colloidal particles small enough to pass through the filter are removed in the region of the negative plate. Suggested uses include concentrating viruses, sterilizing by bacterial removal without heat, radiation, or chemicals, recovery of valuable materials that are in the form of colloidal catalysts, treating process water to remove either valuable or hazardous substances before discharge into streams and recovery of valuable proteins from by-product whey of the cheese industry. (13)

NUCLEAR CHEMISTRY

A development in the field of atomic power which is conservatively regarded as among the most promising advances so far reported and by some enthusiastic members of the chemical engineering profession as "the key to safe, widespread use of atomic power generators" and even as the "capsule cure for atomic power ills" is based on coating nuclear fuels with an inpenetrable layer of ceramic material which will contain gaseous fission products. In this way only the power-producing rays, harmless beyond a few inches, pass through the coating, while everything as big as an atom, even xenon

and krypton atoms, which diffuse readily through metals, can not escape. Uranium metal and its oxides and carbides can be coated, but the compounds are likely to be preferred over the metal. The technique involves the production of fuel beads with a diameter of around 150 microns (0.006 in.) are suspended in a stream of hydrogen in a reactor held at 1800°F while water and aluminum chloride are vaporized and introduced. The beads are coated with a layer of aluminum oxide to the depth of 20 microns, deposited as individual molecules and with no crystal structure, while the gas exiting from the reactor passes dust traps and filters to a scrubber for removal of hydrogen chloride before venting. A further development consists in enclosing the coated beads in graphite spheres of 1.5 in. diameter and of the type used in pebble reactors. Each sphere will contain around one half million beads. Since uranium oxide is not damaged as the metal by radiation, the fuel's life should be greatly extended. Another modification is coating uranium carbide with pyrolytic carbon, this coating slowing fission-produced neutrons to a point where they can enter U-235 atoms to continue the chain reaction. This type of bead would have to be coated at 3000°F and could function in a reactor up to 3500°F. Present boiling water reactors would be freed of the danger of fission products being carried over by steam, and helium as a heat transfer medium is suggested to heat boiler feed water. (14)

The hazards of radioisotope use are being greatly reduced by "caging" these highly active materials in ceramic spheres. Required characteristics of the ceramics are that they must not absorb radiation, must be chemically inert, very refractory, and capable of bonding with inorganic adhesives. On the basis of the properties of the ceramic and bond, the radioisotope can not be physically removed or by solution. Possible uses, depending on clearance, include such self-luminous devices in which radiation from the spheres activate phosphors, radiation sources for industrial gages, process control devices, static eliminators, and medical sources for radiation therapy. By fixing the spheres firmly on a surface, they may radiate alpha particles to remove residual static charges. (15)

A new type of nuclear fission cell operates at 3500°F, the electrons which are emitted go through cesium vapor, and a part of the heat put into the emitter is converted directly to electrical energy. In comparison with a 35% overall efficiency of steam-generating plants, the cell is said to have attained a figure of 10%. Ready passage of electrons from the emitter to the cold collector plate is permitted by ionized cesium gas, which at the same time increases rate of electron emission. These cells are capable, with some modifications, of producing alternating current, as contrasted with thermionic cells, whose direct current require transformation to alternating before long-distance transmission is feasible. (16)

ORGANIC CHEMISTRY

Acrylonitrile, whose major use is in the production of acrylic fibers, will soon be made by a relatively simple and direct process. This consists of passing a mixture of air, ammonia, and propylene over a fluidized bed catalyst, this being supported molybdenum-based material. Pressures are around three atmospheres and temperatures are not over 500°C. Refinery grade propylene and refinery grade ammonia are satisfactory raw materials, and the hydrocarbons may contain as little as 40% of the olefin. The simplest representation of the reaction is the removal of three hydrogen atoms from the end carbon, replacing them by nitrogen, while water is formed by combination of the removed hydrogen with oxygen of the air. Acetonitrile and hydrogen cyanide are valuable by-products. Former methods include dehydration of ethylene cyanohydrin and direct combination of acetylene and hydrogen cyanide. Production of acrylonitrile for 1960 is of the order of 278 million pounds. (17)

Organic compounds capable of forming complexes with a great variety of aromatic compounds and some inorganics and thus changing their physical properties without any alteration of chemical properties may offer many possibilities in chemical industry. These substances are in general polymers of oxazolidinones, in which there is a five membered ring with three carbon atoms, one oxygen atom, and one nitrogen atom. The nitrogen and two of the carbons carry substituents while the third carbon is linked to oxygen, which is not a part of the ring. The linking oxygen is between the carbonyl carbon and one to which is attached a substituent and the third carbon of the ring. The phenol complex is only slightly soluble in water, has no phenolic odor, and is equal in bactericidal power to phenol itself. On the other hand the iodine complex is more soluble than iodine, does not burn the skin, and is equally effective as a biocide. Insecticides and fungicides complexed with the new materials lose none of their primary effects but are less damaging to plants. A saccharin complex with the oxazolidinone has the same degree of sweetness but without the bitter aftertaste. Premature grain germination can be avoided by the ability of the complexing materials to tie up growth hormones which function normally when the polymer is removed by breaking up the complex and washing the grain. (18)

Substitution of 95% oxygen for air in the non-catalytic oxidation of aliphatic hydrocarbons would appear to be a very dangerous procedure in the manufacture of aldehydes, ketones, alcohols, aldehydes, and oxides. However, the addition of oxygen to a very inflammable hydrocarbon is regulated by distributing the oxygen in the hydrocarbon stream through very close control of the hole area of the sparger, by a safety shutdown if the pressure of the oxygen drops too close to that of the hydrocarbon, and by the simultaneous shutting off of oxygen flow and purging the equipment with steam, all valves being actuated by the safety device. The new process greatly increases capacity without additional units, makes possible higher yields of valuable products with reduction of worthless by-products, and gives rapid recovery after process upsets. (19)

Trivalent phosphorus halides, carbonyl compounds, particularly aldehydes and ketones, and esters of trivalent phosphorus acids react to form flame retardants for resin systems, paper, rayon, wood products, and synthetic fibers. Other uses may be as lubricant and gasoline additives. Something like 400 million pounds of polymers could be made self-extinguishing by use of such flame retardants as these complex organophosphorus esters. There are several variations among the reactants, particularly the aldehydes and ketones, so that many functional groups may be introduced into the phosphorus esters. (20)

FUELS

A major problem in connection with boron hydride fuels is the toxicity both of the fuels themselves as they are being handled by personnel and the boron oxide present in jet-engine exhaust products. The fuels proved to be a serious health hazard to test animals on exposure, orally, ocularly, and cutaneously. However, dilute ammonia solution used as a flushing decontaminant proved

effective on the skin of test animals, and is considered suitable for human use. Surgical glove material and silicon ointments were of very limited protective value. Boron oxide, however, showed no signs of poisoning or pneumoconiosis after a number of weeks inhalation by rats and dogs. The eyes of rabbits showed conjunctivitis from exposure to exhaust gases together with some skin irritation. (21)

A new method of recovering crude oil from exhausted reservoirs which may supplement simple water flooding, water saturated with carbon dioxide, and hydrochloric acid to break up carbonate formations, is being referred to as "dry cleaning." In the proposed liquefied petroleum gas which is rich in propane is mixed with water in order to wash as much as twice the quantity of oil from the sands of the reservoir as that recovered by the present processes. (22)

With the increase in the number of offshore oil wells in the lagoon waters of the Gulf of Mexico, a new storage technique is being developed which includes tanks of 100,000 cu. ft. capacity buried flush with the Gulf's floor and operating platforms supported by towers with 18 ft. bases and 8 ft. near the top. Oil and sea-water ballast will be pumped in or out of the tanks as required. Ocean-going tankers can load when pulled up to one of the towers, and the system may also be applied to other bulk liquids for overseas shipments. As much as one million barrels may be stored in water up to 200 ft. in depth. (23)

Tetramethyl load is now being manufactured at the rate of 550 million pounds per year to supplement the standard tetraethyl lead that has been used for many years in antiknock gasoline. The new additive is made in the same way as its predecessor, methyl chloride being roacted with a sodium-lead alloy. It is as safe as the ethyl derivative and is handled in the same way. Although now more expensive, it is said to be specially adapted to high-aromatic gasolines, particularly in those in which olefin content is legally limited and in fuels for small, compact cars. (24)

HIGH POLYMERS

A nonflammable copolymer of trifluoronitrosomethane and tetrafluoroethylene has been developed by the Quartermaster Research and Engineering Center and one of its contractors which is reported as not burning even when a direct flame is played on it. The polymer decomposes at this high temperature to generate a gas which blows out the flame. The most promising use of this copolymer is in coating soldiers' uniforms to protect against the effects of a nuclear blast. (25)

Polycarbonate resins, which are regarded as combining the properties of metals and plastics, were developed simultaneously in Germany and the United States by one large company in each country. These resins are formed by the linking of the residues produced by the splitting out of hydrogen chloride between molecules of phosgene, $COCl_2$ and bisphenol A, which has the structure $HOC_6HC_4C(CH_3)_2C_6H_4OH$, linkage being by carbonate groups. The hydroxyl groups are in the para position with reference to the linking $=C(CH_3)_2$ group. The strength of these plastics compares with those of several metals, and its tensile strength increases with rising temperature. Deformation reaches in 24 hours as much as 75% of its total deformation in a year, and creep distortion can be eliminated with loads kept under 2000 psi. High impact strength, thermal stability, resistance to corrosion, and self-extinguishing properties are those which make polycarbonate resins very valuable materials for the electrical, automotive, and photographic industries. Construction of a plant costing $11 million and with a yearly capacity of 5 million pounds has just been completed, the material previously available having been made in pilot plants. Besides the bisphenol A, something like 50 different polyphenols have been converted to polycarbonates, and a number of these are being further developed. (26)

Eposxy resin cements are now being used to join lengths of thin steel pipe for salt water, oil, and natural gas lines instead of the usual welding techniques. The pipe for these lines vary in diameter from 1.5 to 4.5 in., and have a thickness of 0.1 in. One end of each section of pipe is enlarged slightly so that it will slip over the unenlarged end of the next pipe for a few inches. The epoxy adhesive is spread on the inside of the one pipe and the outside of the other, special crimping tool is applied to bring the two surfaces together, after which the joint is taped. After standing for 48 hours to cure, the joint has reached full strength and can withstand pressures of 800 to 1200 psi, the strength being inversely as the pipe diameter. Thin-walled pipe itself represents a saving and the method of joining still another lowering in cost, and at the same time there is less danger of corrosion. This technique may be extended to the chemical industry, and in many cases plastic pipe may replace steel. (27)

Natural rubber latex irradiated at the plantation with gamma rays produces cross-links with the result that modulus and tensile strength are increased, with strength increasing in proportion to radiation dosage. Extrusion properties and storage life of the irradiated latex are improved, and foam rubber made from it has greater compression values. Preliminary work has been done with cobalt-60, but in commercial practice either electron-accelerating machines or radioisotopes are expected to be used. (28)

CHEMICAL ENGINEERING

In order to determine the explosive patterns of various shaped charges of ultra-sensitive powdered explosives, the Navy has developed a method of safe compression of these materials to 300,000 psi. This is accomplished by placing them in a rubber mold corresponding to the shape that is being investigated in a converted 16-in. naval gun breech. Instead of a hydraulic press, which develops a one-direction thrust, pressure is exerted in all directions by water at 212°F with water or up to 302°F with oil, four hydraulic pumps being used at one time. The charge is thus of uniform density and is free of cracks or cavities. (29)

A new trick in the difficult process of vacuum distillation of heat-sensitive materials at an acceptable throughput rate is the use of a vacuum compression still. A multistage fractionating column has a rapidly rotating impeller in each stage to make up for friction losses, and static vanes to help mass transfer. Pressure drop through the column is said to be less than 10% of that in conventional distillation columns. Liquid from a stage above goes to a collector ring, thence through spaced vertical troughs, where weirs disperse the reflux radially as a spray against the upflowing vapor stream. (30)

References

1) Chem. Week 10/22/60, p. 59
2) Chem. & Eng. News 9/26/60, p. 112
3) Chem. Eng. 10/31/60, p. 41
4) Chem. & Eng. News 9/19/60, p. 85
5) Chem. & Eng. News 10/10/60, p. 96
6) Chem. & Eng. News 9/26/60, p. 110

(Continued on page 40)

WITH THE CHEMICAL CORPS

CHEMICAL CORPS MILITARY DUTY ASSIGNMENTS

(Subject to change as military necessity dictates)

NEW ASSIGNMENTS

NOVEMBER

CAPTAINS

E. D. Crankshaw	Korea
G. E. Dunham	Korea
W. H. Eaton	Ft. Detrick, Md.
S. J. Grochowski	Hq. CmlC. R.&D. Com., D. C.
S. W. Hodges	Rel. Fr. Dtl. in Arty.
*G. R. Marcus	Ft. McClellan, Ala.
D. E. McAlear	Rel. Fr. Dtl. CMLC
J. J. Miller	Ft. Devens, Mass.
P. N. Page	Ft. McClellan, Ala.
N. E. Sudnick	Ft. L. Wood, Mo.
J. E. Taylor	Army Chemical Ctr., Md.

LIEUTENANTS

R. W. Diehl	Army Chemical Ctr., Md.
A. E. Dross	Korea and dtl. in Inf.
J. D. Neubauer	Ft. Rucker, Ala.
C. G. Unger	Tfr. to CmlC. Fr. Arty.

DECEMBER

COLONEL

G. E. Danald	CmlC. Board, Md.

MAJOR

D. C. Kneupfer	USAREUR

CAPTAINS

M. Anderson	Rel. Fr. Dtl. to CmlC.
R. A. Arnberg	USAREUR
P. L. Boulding	Rel. Fr. Dtl. to CmlC.
*J. E. Buckner	CmlC. Fld. Req. Agy, Ala.
V. Ingram	Rel. Fr. Dtl. to CmlC.
A. L. Tories	Ft. McClellan, Ala.

LIEUTENANTS

*J. B. Chapman	Tooele Ord. Depot, Utah
*J. L. Cline	Ft. Ord, Calif.
J. F. Holmes	Ft. McClellan, Ala.
*R. M. McConnell	Ft. Hood, Texas
G. A. Miller	Ft. McClellan, Ala.

JANUARY

LT. COLONELS

E. Datton	Armed Forces Staff Col.
R. M. Ladson	KMAG
R. I. Olson	Korea
E. G. Pike	Belgium

MAJORS

*R. E. Bell	Ft. Benning, Ga.
*R. S. Clark	Korea
M. F. Crawford	Ft. Sam Houston, Texas
D. L. Furches	CmlC. Fld. Regt. Agy, Ala.
R. A. King	Rel. Fr. Dtl. to CmlC.
D. S. Mathewson	USAREUR
J. A. McCurdy	Ft. Lee, Va.
J. T. Waters	Army Chemical Ctr., Md.

CAPTAINS

P. F. Brinkpeter	Ft. McClellan, Ala.
*A. E. Charleston	Korea
*D. R. Deis	Ft. Benning, Ga.
R. C. Effinger	USAREUR
*C. A. Kirkman	Korea
*J. S. Laster	USAREUR
M. J. Nadworny	CmlC Fld. Regt. Agy, Ala.
C. L. Predmore	Ft. Holabird, Md.
*W. D. Sheehan	Hawaii
*A. P. Simkus	Korea
I. J. Turon	Korea

LIEUTENANTS

D. L. Anderson	Army Chemical Ctr., Md.
D. C. Beam	Ft. Bragg, N. C.
M. N. Boggs	Army Chemical Ctr., Md.
L. M. Braswell	Army Chemical Ctr., Md.
H. R. Buckley	Ft. Bragg, N. C.
K. E. Christian	Ft. Detrick, Md.
D. M. Davis	Dugway, Utah
L. D. Doff	Dugway, Utah
J. R. Dunn	Ft. Bragg, N. C.
D. E. Evans	Ft. Ord, Calif.
W. F. Filipkowski	Rel. Fr. Dtl. to Inf.
A. E. Girard	Ft. Detrick, Md.
C. M. Griffin	Rel. Fr. Dtl. to Armor
O. T. Hanna	Army Chemical Ctr., Md.
F. E. Hartley	Ft. Bragg, N. C.
J. A. Hennen	Army Chemical Ctr., Md.
J. W. Hunt	Ft. Bragg, N. C.
F. B. Jones	Ft. Bragg, N. C.
G. M. Kollhoff	Pine Bluff Arsenal, Ark.
C. L. Lamke	Ft. Detrick, Md.
M. A. Miller	Rel. Fr. Detl. in Arty.
J. F. Morris	Ft. Benning, Ga.
D. A. Nydam	Ft. McClellan, Ala.
F. D. Posey	Ft. McClellan, Ala.
R. M. Shobram	Ft. Rucker, Ala.
E. Shimoda	Unasg
D. K. Smith	Army Chemical Ctr., Md.
J. C. Tausta	Army Chemical Ctr., Md.
A. A. Thieme	Army Chemical Ctr., Md.
C. G. Thompson	Dugway, Utah
A. J. Urbano	Army Chemical Ctr., Md.
J. W. Walton	Army Chemical Ctr., Md.
W. E. White	Detailed to Infantry
*J. L. Wockenfuss	USAREUR

RETIREMENTS

NOVEMBER

Lt. Col. C. W. White	Washington, D. C.
Capt. S. Byczynski	New Cumberland, Pa.
Capt. W. H. Maye	Ft. McPherson, Ga.
Capt. O. R. Salmons	Ft. McClellan, Ala.
CWO G. K. Strebig	Ft. Knox, Ky.

DECEMBER

Col. R. B. Caldwell	Ft. Sam Houston, Texas
Lt. Col. L. A. Kief	Washington, D. C.

JANUARY

Col. J. D. Tolman	Ft. McPherson, Ga.
Lt. Col. C. D. Miller	Army Chemical Ctr., Md.
Maj. F. E. Harrison	Ft. Sam Houston, Texas
Maj. V. J. Misiewitz	Ft. L. Wood, Mo.
Capt. L. C. Tompkins	Army Chemical Ctr., Md.

RELIEVED FROM ACTIVE DUTY

NOVEMBER

Lt. K. P. Ragnetti	Ft. McClellan, Ala.
Lt. V. J. Catalano	Army Chemical Ctr., Md.

DECEMBER

Lt. D. W. Goodrich	Army Chemical Ctr., Md.
Lt. J. Greenborg	Ft. Ord, Calif.
Lt. J. P. Mayne	Army Chemical Ctr., Md.

JANUARY

Lt. A. H. Aronson	Army Chemical Ctr., Md.
Lt. D. M. Atkin	Ft. Devens, Mass.
Lt. E. Bourguinon	Army Chemical Ctr., Md.
Lt. W. D. Culbertson	Dugway, Utah
Lt. P. S. Deck	Army Chemical Ctr., Md.
Lt. H. K. Graham	Army Chemical Ctr., Md.
Lt. J. L. Hanson	Rocky Mtn. Arsenal, Colo.
Lt. W. C. Harrison	Camp Irwin, Calif.
Lt. E. F. Jacobs, Jr.	Ft. Bragg, N. C.
Lt. R. W. Kinaman	MDW
Lt. A. R. Kource, Jr.	Army Chemical Ctr., Md.
Lt. M. M. Kulik	Ft. Detrick, Md.
Lt. S. E. Libby	Ft. Hood, Texas
Lt. D. L. Maly	Rocky Mtn. Arsenal, Colo.
Lt. J. N. Mann	Ft. Bragg, N. C.
Lt. McCullough	Memphis, Tenn.
Lt. J. Morrison	Army Chemical Ctr., Md.
Lt. R. Mortlock	Ft. Detrick, Md.
Lt. J. A. Rosado	Ft. Bragg, N. C.
Lt. F. R. Schmidt	Washington, D. C.
Lt. G. J. Skapek, Jr.	Ft. McClellan, Ala.
Lt. A. J. Szur	Ft. Dix, N. J.
Lt. R. Taylorson	Ft. Detrick, Md.
Lt. J. R. Winchester	Army Chemical Ctr., Md.
Lt. P. E. Winston	Army Chemical Ctr., Md.

GIRLS VISIT CHEMICAL CENTER
High school girls from the Institute of Notre Dame, Baltimore, visited the Army Chemical Center in Maryland and toured the new nuclear defense laboratories and the Museum. Chemical Corps scientists were busy answering questions. Nuns from the Institute chaperoned their pupils.

Two students compare the military and civilian gas masks.

FIRST WINNERS of the Chemical Corps-wide Blue Sky Program left to right are: Jack R. Steutz, George P. Smith, Lt. Col. Robert N. Ladson, James R. Rice, Jr., Colonel Maurice A. Peerenboom, chairman of the Blue Sky Program; Louis E. Garono, Sebastian W. Kessler, Alfred N. Bloch, and Bernard Rogge. Seated is Brigadier General William E. R. Sullivan, President, U.S. Army Chemical Corps.

MAJ. SCHADE RECEIVES COMMENDATION MEDAL
The Army Commendation Medal was presented to Major Howard G. Schade by Brig. Gen. Graydon C. Essman, Commanding General of Army Chemical Center, Md. Major Schade is Gen. Essman's new executive officer and was presented with the medal for his work in his last assignment as acting assistant chief of Nuclear Division of the Chief Chemical Officer and assistant Nuclear Effects Advisor to the Chief Chemical Officer in Washington, D.C.

Brig. General Fred J. Delmore, Commanding General U.S. Army Chemical Corps, Research and Development Command, presenting a plaque to Lt. General Chun-po Tang, Commanding General Taiwan Army Logistic Command. Ceremony held in Washington, D.C. (L. to R.) Colonel A. W. Meetze; Brig. General Delmore; Lt. General Chun-po Tang; Major General Ching-Jen Tsai, Commandant Taiwan Supply & Management Command.

Brig. General Scheidecker, new Commanding General of the Air Force Finance Center, and his staff visit Rocky Mountain Arsenal. General Scheidecker is shown here (center) being welcomed by Colonel William J. Allen, Jr. (right) the Commanding Officer of the Rocky Mountain Arsenal.

Colonel Pierre A. Kleff, RMA Deputy Commander Rocky Mountain Arsenal, has retired after 20 years service. He enlisted in the Maryland National Guard in 1929, and entered active duty in 1940 as a Captain. He was commissioned in the Regular Army, Chemical Corps. A retirement certificate and a letter of appreciation from General Lemnitzer, Chairman of the Joint Chiefs of Staff, was presented to Colonel Kleff at a formal retirement parade at Fitzsimmons Army General Hospital.

WITH THE CHEMICAL CORPS

Janette S. Getz, Program Coordinating Office, OCCmlO, being presented a Sustained Superior Performance Award by Col. Michael R. DeCarlo.

Col. A. W. Meetze, Acting Chief Chemical Officer, presenting a Sustained Superior Performance Award to Evelyn W. Zimmerman in ceremony at Gravelly Point, Virginia.

SGT. EKBLAD RECEIVES ARMY MEDAL
Staff Sergeant Eugene R. Ekblad, who has completed 28 years military service retired as Lt. Colonel in the reserves. Brigadier General Graydon C. Essman presented him with the Army Commendation Medal.

Major George H. Roberts, Acting Chief, Administration Division, is presented the Army Commendation Medal with Second Oak Leaf Cluster by Major General Marshall Stubbs, Chief Chemical Officer.

Kathleen R. Smith, Administration Division, being presented an Outstanding Performance Rating by Col. A. W. Meetze, Acting Chief Chemical Officer.

CHEMICAL WARFARE

(Continued from page 29)

out their officers. As one observer indicated, "It was impossible to understand what the Africans said, but from the way they coughed and pointed to their throats, it was evident that, if not suffering from the effects of gas, they were thoroughly scared."[1]

The French Territorials soon followed the Algerians. In contrast, the more highly trained and sophisticated Canadians responded to the attack in a more organized and disciplined manner. Largely as the result of the prompt action of the Canadians, Ypres was kept from becoming a rout. The key to the action was the training, discipline, and education of the Canadian troops.

A Study on Imaginative Use of Chemical Warfare: In the German defense of the Vesle River against the AEF in World War I, gas was employed by the Germans with very effective results. In the river crossing, U.S. gas masks became wet and generally useless as protection from the intermittent gas barrages which the Germans spread in the river bottom. To the hundreds of men wounded by machine gun, rifle, and artillery fire were added others seriously gassed.[2]

The only way to secure effective results from any combat weapon is to be thoroughly trained in its use. Training in chemical weapons is no different from training with machine guns or tanks. Dynamic training will result in the dynamic use of the weapon in combat. Routine and minimum training rarely produces spectacular results.

The German defense of the Vesle came close to succeeding because of the imaginative use of gas, which was in turn strongly indicative of a high state of training.

A Study of the Use of Chemicals versus High Explosive Weapons: The use of gas by the U.S. 78th Division in the Meuse-Argonne has been revealed by Dr. Brooks E. Kleber, Chemical Corps Historian.[3] He indicates that "On 1 November (1918) the First Army renewed its attack against the Kriemhilde position. One of the strongest points in the German line lay in front of the 78th Division . . . The keys to this sector were two large woods, the Bois de Bourgogne and the Bois des Loges. The artillery preparation for the attack of the 78th Division began on 30 October, directed pri-

marily against the Bois de Bourgogne and the Bois des Loges. The division's light artillery fired mustard gas at all known battery positions in the Bois de Bourgogne, expending almost 30,000 rounds during a 12-hour period. Early the next morning corps artillery contributed 400 105mm shells, making a total of over 41 tons of mustard fired against the woods. Against the smaller Bois des Loges on the division's right no gas was used, but an estimated 12,625 75mm HE, 3,000 155mm HE, and 650 phosphorous shells were fired. Despite this extensive HE preparation against the Bois des Loges, the attacking American troops encountered an undaunted enemy. Captured prisoners reported that losses from bombardment were slight. The situation in the Bois de Bourgogne, where gas had been used, was striking and different. There the enemy defenses had been completely neutralized and the troops advanced without enemy resistance from the mustardized area. This woods had been occupied almost exclusively by enemy machine gun units protecting the guns of the German 76th Reserve Division. Enemy reports revealed the effectiveness of the gas attack. Seven of nine batteries of the division Near Bombardment Group were put out of action, and two regimental headquarters had to be abandoned. By the night of 31 October the 76th Reserve Division suffered 210 gas casualties."

A Critique

As these case studies reveal, chemical weapons can be highly effective. They combine area coverage, selectivity of casualty effect, surprise, and economy. The one ingredient which they do not contain is standardized effects. By this I mean that each gas attack tends to be different, varying with the imagination of the commander, training of the troops, and such variables as weather and terrain. No two gas attacks are the same.

Altogether about 10,000,000 artillery shells were filled with mustard gas and of these approximately 9,000,000 were fired in World War I. These 9,000,000 shells produced 400,000 casualties, or one casualty for every 22.5 mustard shells fired. Thus, mustard gas shells proved to be nearly five times as effective as shrapnel and high explosive.

Does our present unit chemical weapons training program reflect the dynamic nature of this highly efficient weapon from the viewpoint of both its defensive and offensive aspects? Have we included simulated chemical attacks in our problems on river crossings? Are troops in field training subjected to simulated toxic chemical attack at mealtime and during rest periods, in rear areas, while in attack formations, and at night? Have our troops slept while wearing a protective mask? Have they worn it while operating their unit and individual weapons? Has anyone in your unit used the gas identification kit in the field under a simulated tactical situation? How many men really know how to use it? Have you and your men injected yourselves with an ampule of simulated atropine, the treatment for nerve gas poisoning? (You know most of us flinch on this self treatment the first time we plunge a 1-inch needle into our own flesh.) To some commanders the answers to these questions may be yes, but more often than not the answer is no.

Chemical warfare training by its nature tends to be somewhat more technical than other military training, but not overly so. At the present time there are many U.S. Army films, manuals, and other training literature and aids which reduce chemical weapons training to a level of easy comprehension for all military personnel. No need for the troop commander to be a chemist, but by properly employing available training aids, by using imagination, and by programming personnel into CBR Training Courses whenever possible, a highly effective and flexible CBR training program can be developed.

A Challenge

Chemical weapons are powerful in the hands of trained troops. In the hands of poorly trained troops, they can be just as great a liability. With the constant development of agents possessing a broad spectrum of physiological and psychological effects, ranging from extreme lethality to temporary mental or physical incapacitation, it is becoming critically necessary for all commanders to stress imaginative and dynamic chemical, and related biological, weapons training. Failure to do so will result in few of the potentialities being exploited, and most certainly, the troops will be vulnerable to chemical attack.

The real challenge to chemical weapons training is to the company commander. It is he who determines the degree of readiness of his unit for CBS agents.

Training materials and guidance are available, but the challenge and responsibility for developing chemical weapons training rests with the commander.

THE ULTIMATE OBJECT OF ALL MILITARY TRAINING IS SUCCESS IN BATTLE!

REFERENCES

1. Edmonds, J. E., Brigadier General and Wynne, G. C., Captain, *Military Operations—France and Belgium, 1915*, MacMillan and Co., Limited, St. Martin's Street, London, 1927
2. Every, Dale Van, *The AEF In Battle*, D. Appleton's Company, New York-London, 1920
3. Kleber, Dr. Brooks E., "The 78th Division Uses Gas In the Meuse-Argonne." *Armed Forces Chemical Journal*, January-February 1960.

MISS VICK MOVES TO NORTH CAROLINA

Miss Elizabeth Vick, editorial assistant on the Armed Forces Chemical Journal, is resigning her position to return to her home at Charlotte, N.C. She has been active in the publication of THE JOURNAL for the past 4½ years.

Miss Vick had been with the Federal Government for 30 years. During 11 years of that time she was the editor of the U.S. Air Force Statistical Digest. She is well known to the Board of Directors of the Armed Forces Chemical Association because during her tenure, she would volunteer to take the minutes of the annual meetings.

The staff of A.F.C.A. is sorry to see her go.

A. F. C. A. AFFAIRS

NEW ENGLAND CHAPTER GOES INTERNATIONAL

Helge Holst, John J. McDonald, Walter E. Mutz, Chenery Salmon, and Harry A. Wansker were invited to attend the dinner held in honor of Secretary General Paul-Henri Spaak, North Atlantic Treaty Organization, at the Fletcher School of Law and Diplomacy of Tufts University in mid-November. Mr. Spaak delivered a series of three lectures on European Economic Integration and The Western Alliance at the University. This is the fourth annual series of lectures given at the William L. Clayton Center for International Economic Affairs at Tufts.

Members and wives of the New England Chapter of the Armed Forces Chemical Association meet with Lieut. Gen. Leon W. Johnson at SHAPE in Paris where the visitors are briefed on NATO. The A. F. C. A. members represented the Boston Regional Conference on NATO Affairs, Inc. at the Oslo meeting of the Atlantic Treaty Association Conference and are on their way home. The visitors are: Mr. and Mrs. Helge Holst, John J. McDonald, Walter Mutz, Chenery Salmon, and Harry Wansker.

The five memers of the New England Chapter previously attended Atlantic Treaty Association Conference in Oslo, and also visited NATO where they were briefed by Lieutenant General Leon W. Johnson, USAF. They were accompanied by their wives on the European trip last summer.

Harry A. Wansker is founder and past-president of the Boston Regional Conference on NATO Affairs, Inc., and Chenery Salmon was a vice-president. The Regional Conference was host to the Atlantic Treaty Association in Boston and housed their guests in the private homes of members and frends during the visitors' stay.

AFCA TOUR—Members of the AFCA, Chesapeake Chapter, Army Chemical Center, Md., tour the facilities of the W. R. Grace Co. in Clarksville, Md., after their Chapter meeting.

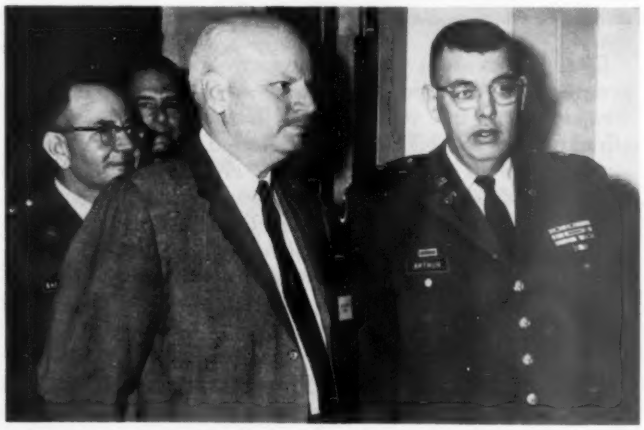
M/Sgt. Richard E. Lindsay has been assigned to the Chemical Section of the 7th Infantry Division in Korea. Sergeant Lindsay (L) is being greeted by Sergeant 1st Class Leo R. Lanz (R) on his arrival. The Section helps conduct classes in all phases of CBR weapons. Sgt. Lindsay is a member of the Fort McClellan Chapter.

GENERAL STUBBS COMMENDS DALLAS CHAPTER PRESIDENT

Dr. Herman W. Dorn has been commended by General Marshall Stubbs, Chief Chemical Officer of the Army, for the suggestions he has contributed to the Blue Sky Program.

Dr. Dorn, who is Director of Research at Parmae Laboratories in Dallas, Texas, is also the new A.F.C.A. Chapter President in that city. He is a Lt. Colonel in the Chemical Corps Reserves, and the author of both patents and scientific papers in the food and drug fields.

A Post Doctorate Fellow in engineering biochemistry at the University of Iowa, and president of Frozen Food Institute, New York City, Dr. Dorn now consults in food technology, drugs and pharmacology as well as biochemical planning, research and development.



REPRESENTATIVE ROBERT L. F. SIKES (D. FLA.) toured the Army Chemical School at Fort McClellan and predicted that chemical and biological weapons would continue to grow in defense planning. Mr. Sikes holds the rank of Brigadier General in the Army Reserves. He is seen here (left) with Colonel Frank McArthur.

MIDWEST CHAPTER

Major General James W. Wilson, Director of Material for the Strategic Air Command, spoke at a joint meeting of the Midwest Chapter, Armed Forces Chemical Association, and the Chicago Chapter of the National Sojourners, on October 6, 1960.

AF R&D

(Continued from page 12)

CONTRACTOR	LOCATION
Harvard University	Cambridge, Mass.
Hebrew University	Jerusalem, Israel
High Altitude Observatory	Boulder, Colo.
Hoffman Labs.	Los Angeles, Calif.
Hooker Chemical Corp.	Niagara Falls, N.Y.
Houghton, E. F. & Co.	Philadelphia, Penna.
Houze Glass Corp.	Pt. Marion, Penna.
Hu"man Microanalytical Lab.	Wheatridge, Colo.
Hughes Aircraft Co.	Culver City, Calif.
Hull University	Hull, England
Human Sciences Research	Alexandria, Va.
Imperial College of Science	London, England
Inan Prof. Mustafa	Istanbul, Turkey
Indiana University	Bloomington, Ind.
Industrial Biology Research	Philadelphia, Penna.
Institute de Ciencias	Madrid, Spain
Institute Fuer Tech-Mech	Munich, Germany
Institute de Recherches	Paris, France
Institute Theorelcl	Berlin, Germany
Ionospheric Institute	Breisach, Germany
Iowa State College	Ames, Iowa
Isotopes, Incorporated	Westward, N.J.
Israel Institute of Technical Research	Haifa, Israel
Johns Hopkins University	Baltimore, Md.
Jost Wilhelm	Goettingen, Germany
Kansas State College	Manhattan, Kans.
Karolinska Institute	Stockholm, Sweden
Kent State University	Kent, Ohio
Kerckhoff, W. G. Institute	Bad Nauheim, Germany
Kilgore Manufacturing Co.	Westerville, Ohio
Kluge, Dr. Ing. W. Prof.	Stuttgart, Germany
Koppers Company, Inc.	Pittsburgh, Penna.
Kyoto University	Kyoto, Japan
Lab Jes Hautes Press	Bellevue, France
Lab de Elec de Polytechnic	Milan, Italy
Lalex, Incorporated	El Seguendo, Calif.
Lear, Incorporated	Grand Rapids, Mich.
Ledoux and Company	Teaneck, N.J.
Leemath, Incorporated	Syosset, N.Y.
Lehigh University	Bethlehem, Penna.
Leist Ing. K. Dr.	Aachen, Germany
Leland Stanford University	Stanford, Calif.
Linde Air Products	New York, N.Y.
Linde Crystal Products	East Chica, Ind.
Link Aviation Devices	Binghamton, N.Y.
Little, A. D., Inc.	Cambridge, Mass.
Litton Industries	Beverly Hills, Calif.
Lockheed Aircraft	College Park, Md.
Lockheed Aircraft	Sunnyvale, Calif.
Lockheed Aircraft	Van Nuys, Calif.
Lockheed Electric Co.	Plainfield, N.J.
Lovelace, W. R., II	Albequerqut, N.M.
MSA Research Corp.	Callery, Penna.
Mach Engineering Co.	Alberquerque, N.M.
Manufacturers Labs, Inc.	Cambridge, Mass.
Marine Corps Air Station	El Toro, Calif.
Marquardt Aircraft	Van Nuys, Calif.
Martin Company	Baltimore, Md.
Martin Company	Orlando, Fla.
Massachusetts Inst. of Technology	Cambridge, Mass.
Materials Research Company	Yonkers, N.Y.
Max Planck Institute Feur	Lindau, Germany
Max Planck Institute Biol	Tubingen, Germany
McDonnell Aircraft	Saint Louis, Mo.
McGill University	Montreal, Canada
McGraw-Hill Publishing Co.	New York, N.Y.
McKiernan-Terry Corp.	Dover, N.J.
McMaster University	Hamilton, Canada
Medical College St. Bartholomew	London, England
Medical Research Labs.	Dublin, Ireland
Mellon Institute	Pittsburgh, Penna.
Mediterranean Research	Nice, France
Melpar, Incorporated	Falls Church, Va.
Metal Hydrides, Inc.	Beverly, Mass.
Metals Research Devel, Inc.	Exeter, Penna.
Miami University	Oxford, Ohio
Michigan State College	E. Lansing, Mich.
Midwest Research Institute	Kansas City, Mo.
Mine Safety Appliances Co.	Los Angeles, Calif.
Mine Safety Appliances Co.	Pittsburgh, Penna.
Mineralogis Geo-Muse	Oslo, Norway
Minneapolis-Honeywell Regulator Co.	Boston, Mass.
Minneapolis-Honeywell Regulator Co.	Hopkins, Minn
Minneapolis-Honeywell Regulator Co.	Minneapolis, Minn.
Monsanto Chemical Co.	Boston, Mass.
Monsanto Chemical Co.	St. Louis, Mo.
Monsanto Chemical Co.	Dayton, Ohio
Napolintano, Luigi G.	Naples, Italy
NARMCO, Inc.	San Diego, Calif.
National Academy of Sciences	Washington, D.C.
National Carbon Co.	New York, N.Y.
National Cash Register Co.	Dayton, Ohio
National Company	Malden, Mass.
National Inst. Tech. Aero	Madrid, Spain
National Northern Corp.	West Hanover, Mass.
National Observation Par	Paris, France
National Research Corp.	Newton Highland, Mass.
Naval Ordnance Testing Sta.	China Lake, Calif.
Navy Department	Washington, D.C.
Navy Dept. Bur. Aeronautics	Washington, D.C.
Navy Dept. Bur. Ordnance	Washington, D.C.
Navy Dept. Bur. Ships	Washington, D.C.
Navy Dept. NRL	Washington, D.C.
Navy Dept. ONR	New Brighton, Minn.
Navy Radio Defense Lab.	San Francisco, Calif.
New Mexico College	State College, N.M.
New York University	New York, N.Y.
Nobel Institute of Physics	Stockholm, Sweden
North American Aviation	Canoga Park, Calif.
North American Aviation	Downey, Calif.
North Carolina State College Agr./Eng.	Raleigh, N.C.
Northeastern University	Boston, Mass.
Northwestern University	Evanston, Ill.
Nuclear Development Assn.	White Plains, N.Y.
Nuclear Metals, Inc.	Cambridge, Mass.
Nuclear Science Eng. Co.	Pittsburgh, Penna.
Ohio State University	Columbus, Ohio
Oklahoma A&M College	Stillwater, Okla.
Olin Mathieson Chemical Corp.	New Haven, Conn.
Olin Mathieson Chemical Corp.	Niagara Falls, N.Y.
Oronite Chemical Co.	San Francisco, Calif.
Overberger, Dr. C. C.	Brooklyn, N.Y.
Owens Corning Fiber Glass Co.	Toledo, Ohio
Oxford University	Oxford, England
Peninsular Chemical Research	Gainesville, Fla.
Penn. Salt Mfg. Co.	Wyndmoor, Penna.
Penn. State College	State College, Penna.
Perkin-Elmer Corp.	Norwalk, Conn.
Philco Corporation	Philadelphia, Penna.
Phillips Petroleum Co.	Bartleville, Okla.
Phoenix Chemical Lab.	Chicago, Ill.
Physics Engineering & Chemistry	Boulder, Colo.
Physics Lab.	Paris, France
Physikalische Meteorology	Davos Plat, Switzerland
Pickard and Burns	Needham, Mass.
Picker X-Ray Corp.	Cleveland, Ohio
Pittsburgh Plate Glass Co.	Springdale, Penna.
Plasmadyne Corp.	Santa Ana, Calif.
Plesset E. H. Associates, Inc.	Los Angeles, Calif.
Polytechnic Institute	Brooklyn, N. Y.
Prestoseal Mfg. Corp.	Long Island City, N. Y.
Princeton University	Princeton, N. J.
Purdue University	Lafayette, Ind.
Quantum, Inc.	Cheshire, Conn.
Radiation Appliances, Inc.	Long Island City, N. Y.
Radiation Count Lab.	Chicago, Ill.
Radio Corp. of America	Harrison, N. J.
Radio Corp. of America	Somerville, N. J.
Ramo Woolridge Co.	Los Angeles, Calif.
Ramo Woolridge Co.	Cleveland, Ohio
Rand Corporation	Santa Monica, Calif.
Raytheon Mfg. Co.	Waltham, Mass.
Reaction Motors Co.	Denville, N. J.
Rensselear Polytechnic Inst.	Troy, N. Y.
Republic Aviation Corp.	Farmingdale, N. Y.
Republic Aviation Corp.	New York, N.Y.
Research Chemical Co.	Burbank, Calif.
Research Incorporated	Hopkins, Minn.
Resin Industries	Santa Barbara, Calif.
Revere, Althea	Vineyard H., Mass
Rias Incorporated	Baltimore, Md.
Rockwood Sprinkler Co.	Worcester, Mass.
Rohm and Haas Co.	Philadelphia, Penna.
Rosemount Aeronautics Lab.	Rosemount, Minn.
Royal College of Science	Glasgow, Scotland
Royal Inst. of Technology	Stockholm, Sweden
Saint Joseph College	West Hartford, Conn.
Sawyer, A. J. Co.	East Aurora, N. Y.
Scherhag, Prof. R.	Berlin, Germany
Schjedahl, G. T. Co.	Northfield, Minn.
Schuman, Dr. W. O.	Menchen, Germany
Seiscor Mfg. Co.	Tulsa, Okla.
Shell Development Corp.	Emeryville, Calif.
Shell Oil Co.	New York, N. Y.
Smithsonian Institute	Washington, D. C.
Smyth Research Associates	San Diego, Calif.
Solar Aircraft Co.	San Diego, Calif.
Southern Research	Birmingham, Ala.
Southwest Research Inst.	San Antonio, Texas
Sperry Gyroscope Corp.	Great Neck, N. Y.
Standard Oil Development Co.	Elizabeth, N. J.
Stanford Research Institute	Menlo Park, Calif.
Stauffer Chemical Co.	New York, N. Y.

(Continued from page 40)

AF R&D

(Continued from page 39)

CONTRACTOR	LOCATION
Stearns Roger Mfg. Co.	Denver, Colo.
Stevens Institute	Hoboken, N. J.
Stewart-Warner Corp.	Indianapolis, Ind.
Sunstrand Machine Tool Mfg. Co.	Pocoima, Calif.
Sylvania Electric Products	Bayside, N. Y.
Syracuse University	Syracuse, N. Y.
Task Corporation	Anaheim, Calif.
Technesche Hochschul	Vienna, Austria
Technical Operations Inc.	Burlington, Mass.
Tech Research Group	New York, N. Y.
Technion Research Development	Haifa, Israel
Texas A. & M. College	College Station, Texas
Texas Butdne Chemical Co.	Channelville, Texas
Thiokol Corporation	Elkton, Md.
Thiokol Corporation	Trenton, N. J.
Thiokol Chemical Co.	Brigham City, Utah
Thiokol Chemical Co.	Denville, N. J.
Thompson Products	Cleveland, Ohio
Tokyo University of Education	Tokyo, Japan
Tracerlab Inc.	Richmond, Calif.
Transitron Electric Co.	Melrose, Mass.
Tribo Natics Lab.	Vermillion, Ohio
Tufts College	Medford, Mass.
Tuskegee Institute	Tuskegee, Ala.
Union Carbide Chemicals Co.	Indianapolis, Ind.
Union Carbide Cehmicals Co.	Kokomo, Ind.
Union Carbide Chemicals Co.	New York, N. Y.
Union Carbide Chemicals Co.	Niagara Falls, N. Y.
Union Carbide Chemicals Co.	Cleveland, Ohio
United Aircraft Co.	Hartford, Conn.
United Aircraft Corp.	United, Fla.
U. S. Borax Research Corp.	Anaheim, Calif.
U. S. Rubber Co.	Wayne, N. J.
Universal Scientifics	Vincennes, Ind.
University of Aberdeen	Aberdeen, Scotland
University of Alaska	College, Alaska
University of Allahabad	Allahabad, India
University of Arizona	Flagstaff, Arizona
Univ. of Arizona State College	Tucson, Arizona
University of Barcelona	Barcelona, Spain
University of Belfast	Belfast, Ireland
University of Arkansas	Fayetteville, Arkansas
University of Athens	Athens, Greece
University of Bonne	Bonne, Germany
University of Brazil	Rio de Janerio, Brazil
University of Brussels	Brussels, Belgium
University of Buffalo	Buffalo, N. Y.
University of California	Berkeley, Calif.
University of California	Los Angeles, Calif.
University of Cambridge	Cambridge, England
University of Chicago	Chicago, Ill.
University of Cincinnati	Cincinnati, Ohio
University College	London, England
University College	Galway, Ireland
University College N. Staffordshire	Staffordshire, England
University College of Wales	Aberystwyt, Wales
University di Pavia	Pavia, Italy
University of Colorado	Boulder, Colo.
University of Dayton	Dayton, Ohio
University of Denver	Denver, Colo.
University of Detroit	Detroit, Mich.
University of Durham	Durham, England
University of Edinburgh	Edinburgh, Scotland
University of Florida	Gainesville, Fla.
University of Fribourg	Fribourg, Switzerland
University of Genova	Genova, Italy
University of Ghana	Leon, Ghana
University of Heidleberg	Heidleberg, Germany
University of Hawaii	Honolulu, Hawaii
University of Illinois	Urbana, Ill.
University of Liecester	Leicester, England
University of Lapaz	Lapaz, Bolivia
University of Lund	Lund, Sweden
University of Manchester	Cheshire, England
University of Michigan	Ann Arbor, Mich.
University of Milan	Milan, Italy
University of Minnesota	Minneapolis, Minn.
University of New Hampshire	Durham, N. H.
University of Notre Dame	Notre Dame, Ind.
University of Nottingham	Nottingham, England
University of Organis-Chem.	Vienna, Austria
University of Pennsylvania	Philadelphia, Penna.
Uliversity of Pittsburgh	Pittsburgh, Penna.
University of Rochester	Rochester, N. Y.
University of Saskatchewan	Saskatoon, Canada
University of Sheffield	Sheffield, England
University Southern California	Los Angeles, Calif.
University of Texas	Austin, Texas
University of Utah	Salt Lake City, Utah
University of Virginia	Charlottesville, Va.
University of Washington State	Seattle, Wash.
University of Wisconsin	Madison, Wisc.
Utah State Agr. College	Logan, Utah
Vickers Incorporated	Detroit, Mich.
Vitro Corp of America	Orange, N. J.
Washington State College	Pullman, Wash.
Washington University	St. Louis, Mo.
Waters Associates	Framingham, Mass.
Wayne University	Detroit, Mich.
Weibull Waloddi	Brosarps, Sweden
Weismann, Institute	Rehoveth, Israel
Wentworth Institute	Boston, Mass.
Wesleyan University	Middletown, Conn.
Western Reserve University	Cleveland, Ohio
Westinghouse Electric Corp.	Dayton, Ohio
Westinghouse Electric Corp.	Boston, Mass.
Westinghouse Electric Corp.	Kansas City, Mo.
Wundt Rolf	Dayton, Ohio
Wyandotte Chemical Corp.	Wyandotte, Mich.
Wyeth Laboratories	Baltimore, Md.
Yale University	New Haven, Conn.
Young Development Lab.	Rocky Hill, N. J.

DIED

Captain A. A. Bernheim, born at Sutter's Fort, an Army Post on the battlefield of the Little Big Horn, in 1877. He had served with Teddy Roosevelt in Cuba, the Boxer Rebellion, Mexican Border Campaign, and as a Captain with the First Gas Regiment in the AEF. Bernheim completed 26 years of active service as M/Sgt. in charge of the PX at the Army Chemical Center. He continued to operate the PX as a civilian for another 24 years, and retired in 1948. He died in Los Angeles and was buried in Arlington National Cemetery.

Lt. Col. Harold B. Rodier, first editor of the Armed Forces Chemical Journal, of leukemia at Walter Reed Hospital. Col. Rodier left the Army after World War II and edited THE JOURNAL as well as REVEILLE, a publication of the 42nd (Rainbow) Division. He had retired six years ago and moved to Clearwater, Florida. Col. Rodier, who was 64 at the time of his death, began his military service under General Pershing on the Mexican Border. He served with the Rainbow Division in World War I and with the Chemical Corps in World War II.

Burial was in Arlington National Cemetery.

GRASS WAS GREEN AT PIGSKIN SCENE

Philadelphia wanted the stadium grass a springtime green for the 1960 Army-Navy football game instead of the fall brown seasonally in vogue with mother nature. A greensward made a better contrast for gridiron markings and allowed better visibility for both stadium audiences and televiewers, according to Robert W. Crawford, Commissioner of the Philadelphia Department of Recreation.

Allied Chemical provided a green grass dye and Crawford's department supplied a ten-man spraying team to make the field green for the pigskin classic.

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11) Off. Tech. Serv. 60-272, 9/2/60
12) Chem. Week 11/5/60, p. 70
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17) Chem. Eng. Progress 10/60, p. 65
18) Chem. & Eng. News 9/5/60, p. 56
19) Chem. & Eng. News 10/10/60, p. 53
20) Chem. & Eng. News 9/26/60, p. 102
21) Off. Tech. Serv. 60-316, 10/28/60
22) Chem. Week 10/15/60, p. 72
23) Chem. Week 10/1/60, p. 32
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25) Chem. & Eng. News 9/26/60, p. 105
26) Chem. Eng. Progress 10/60, p. 104
27) Chem. Eng. 10/31/60, p. 39
28) Chem. & Eng. News 9/26/60, p. 41
29) Chem. Week 11/5/60, p. 70
30) Chem. & Eng News 9/19/60, p. 76

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